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ASSOCIATION OF SCLEROSIS OF THE CEREBRAL BASAL VESSELS WITH OPTIC ATROPHY AND CUPPING

REPORT OF TEN CASES

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Optic atrophy with excavation of the disk and especially with marginal cupping, as seen in glaucoma, is a puzzling condition when the intra-ocular tension is persistently low. In these cases a diagnosis of glaucoma is generally made notwithstanding the subnormal tension. This curious and contradictory condition has been explained in the following ways:

Some authors believe that during a preceding stage the tension has been sufficiently raised to cause cupping, but that now the tension is permanently low. E. Fuchs [1] suggested that the lamina cribrosa in these cases is particularly weak, for some unknown reason, and cannot resist even the usual normal pressure. He did not believe that a simple optic atrophy appears from the beginning with a deep excavation and nasally displaced blood vessels, and thought it more likely that a combination of optic atrophy and glaucoma simplex is present. Elschnig [2] denied the weakness of the lamina cribrosa and said that glaucomatous disease of the optic nerve results from a solution of the nerve fibers and the framework of the optic nerve by an abnormal action of the intra-ocular fluid as it passes through the optic nerve. Even if the intra-ocular tension is low, provided that there is too much or abnormal fluid passing out by the optic nerve, the cavernous glaucomatous optic atrophy may result just as the optic nerve process may continue even after the ocular pressure is reduced.

I have observed ten cases belonging to this group since 1928, but to classify them as examples of atypical glaucoma did not seem plausible to me. As these patients were all beyond middle age, the possible presence of sclerosis of the basal vessels of the brain causing an optic atrophy by pressure suggested itself as an explanation for this condition, especially as the usual causes for optic atrophy were absent.

Read before the American Ophthalmological Society, New London, Conn., June 27, 1932.

1. Fuchs, E.: Ztschr. f. Augenh. **25**:108, 1911.
2. Elschnig: Ztschr. f. Augenh. **52**:287, 1925.

It has been known for many years that the optic nerves may be affected in arteriosclerosis of the larger vessels at the base of the brain. As early as 1852, Türck [3] described visual disturbances from compression of the basal optic pathways in cerebral disease, and showed that the optic nerve suffered when the arteria corporis callosi was affected, and that the posterior communicating artery and internal carotid may compress the optic tracts. Herman Knapp,[4] in 1875, described a nasal field defect in a case in which the internal carotid pressed on the lower and outer surfaces of the optic nerve, thus affecting the uncrossed bundle. R. Otto [5] reported on four cases of arteriosclerotic disease of the internal carotid and ophthalmic arteries which, on anatomic examination, showed a dilated and hardened vascular lumen causing atrophy of the optic nerves by mechanical pressure. Liebrecht [6] reported on seven cases of arteriosclerosis of the internal carotid and ophthalmic arteries, and believed that the optic nerve suffers more frequently than is generally recognized. According to this author the pressure is not exerted in the optic canal but in the following three places: (1) in the fibrous optic canal by pressure of the ophthalmic artery on the optic nerve; (2) by the ascending internal carotid against the falciform dural fold; (3) midway between the canal and chiasm where the internal carotid artery and anterior cerebral artery cross under and over the optic nerve. Wilbrand and Saenger and Marburg believe that the changes in the optic nerves do not result from pressure but are trophic from nutritional disturbances, the arteriosclerosis of the smaller vessels causing perivascular softening on account of the impervious vessel wall.

As this condition was only found at autopsy, there is no available information about the clinical ophthalmic findings. The demonstration of calcification of the basal vessels in the living was not made until some time after the discovery of the roentgen rays. Schüller,[7] in 1921, demonstrated for the first time x-ray changes in a case of Lauber's. Hornicker [8] was the first ophthalmologist to report that sclerosis of the basal cerebral vessels can be demonstrated in the living by the x-rays. This author stated that, in the case described, in the anteroposterior picture the right calcified tortuous and dilated internal carotid appeared

3. Türck: Sitzungsb. d. k. Akad. d. Wissensch. Math-naturw.Cl., Wien. **9**: 299, 1852.

4. Knapp, Herman: Jahresb. f. Ophth., 1875, p. 372.

5. Otto, R.: Untersuchungen über Sehnervenveränderungen bei Arteriosklerose, Berlin, Julius Springer, 1893, p. 132.

6. Liebrecht: Sehnerv und Arteriosklerose, Arch. f. Augenh. **44**:237, 1907.

7. Schüller: Sitzungsb. d. ophth. Gesellsch., Wien, June 20, 1921; Ztschr. f. Augenh. **47**:146, 1922.

8. Hornicker: Ber. d. deutsch. ophth. Gesellsch., 1924, p. 283.

in the shape of a horizontal eight in the right orbit, and the left internal carotid was represented in the left orbit as a horseshoe with its opening temporal. Pincherle,[9] a student of Schüller, demonstrated that in the profile pictures calcification of the internal carotid in the sinus cavernosus appears as a horizontal running line or shadow in the sella, and in the anteroposterior picture calcification of the internal carotid appears as a vertically placed shadow at the inner extremity of the superior orbital fissure.

Schüller [10] said:

The calcification of the basal cerebral arteries appears in the roentgenogram as delicate shadow bands or limelike double contours, rings or ring segments which in the profile view appear in the region of the sella turcica, while in the anteroposterior picture they appear in the superior orbital fissure or in the optic canal.

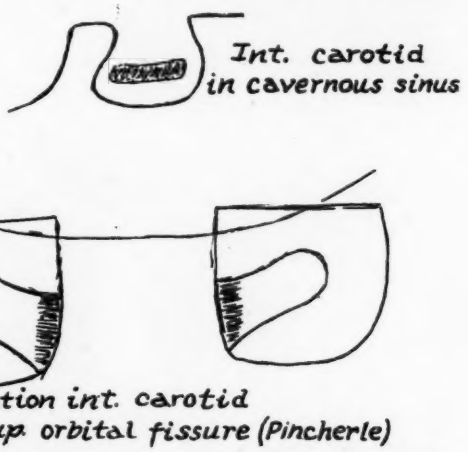

Fig. 1.—Calcification of the internal carotid in the cavernous sinus and in the superior orbital fissure.

According to the degree of tortuosity and the dilatation of the diseased arteries, the form and position as well as the caliber of the corresponding shadow pictures vary. Aneurysms of the basal arteries usually are recognized in the x-ray picture by calcified shells in their wall, which project as delicate arcuate shadow lines in the region above, to one side or behind the dilated sella.

The following cases found in the literature without an exhaustive search illustrate the condition described in this paper. H. Lauber [11] has observed a glaucomatous marginal excavation when repeated tonometric examination never showed a higher tension than 18 (Schiötz). Gradle [12] regarded glaucoma simplex without tension as a special disease, begin-

9. Pincherle: Ueber die röntgenographische Darstellung verkalkter Hirnarterien, Fortschr. a. d. Geb. d. Röntgenstrahlen **29**:215, 1921.

10. Schüller: Röntgenpraxis **2**:269, 1930.

11. Lauber, H.: Ztschr. f. Augenh. **25**:110, 1911.

12. Gradle, H. S.: Glaucoma Simplex, Arch. Ophth. **46**:117 (March) 1917.

ning as an intra-ocular neuritis with formation of Schnabel's caverns, which is not amenable to treatment and is probably toxic. Kayser [13] reported on a patient, aged 63, with optic atrophy, deep excavation, vision of 6/12, and a tension never over 22 for many years. He assumed a primary lacunar optic atrophy with large cavities so that even the normal pressure was sufficient to cause cupping.

That optic atrophy can occur with deep marginal excavation in the form of a descending atrophy without glaucoma was especially well demonstrated in cases of wood alcohol poisoning and in the presence of hypophyseal tumors. Gruening,[14] in an article on wood alcohol

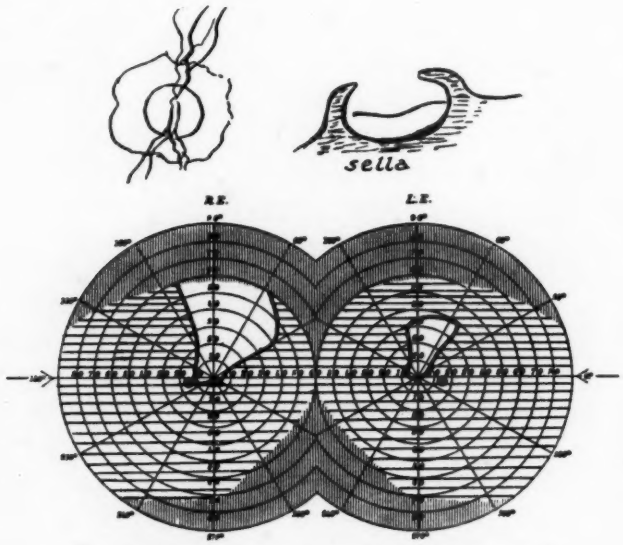

Fig. 2.—Drawings and visual fields in case 1.

amblyopia, showed how the excavation of the optic disk in this condition resembles that of glaucoma, without apparent tension; this excavation was strikingly illustrated in the accompanying drawing by Dr. Percy Fridenberg. Morrison,[15] in a case of toxic amblyopia from wood alcohol poisoning, observed five months later suspicious cupping with optic atrophy; notwithstanding trephining and reduction of tension, the cupping increased and vision was lost. Thiel [16] was also struck by the thought that sclerosis of the basal vessels can account for glaucoma without increased pressure. He reported two cases of glaucoma without increased pressure which showed roentgenographically changes of

13. Kayser: Klin. Monatsbl. f. Augenh. **66**:923, 1921.

14. Gruening, E.: Arch. Ophth. **39**:333, 1910.

15. Morrison: Am. J. Ophth. **5**:645, 1922.

16. Thiel: Glaucom ohne Hochdruck, Ber. d. deutsch. ophth. Gesellsch., 1930, p. 133.

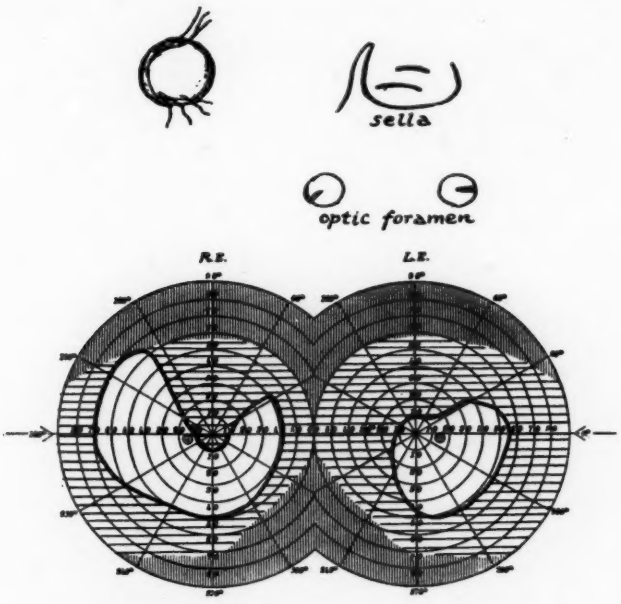

Fig. 3.—Drawings and visual fields in case 2.

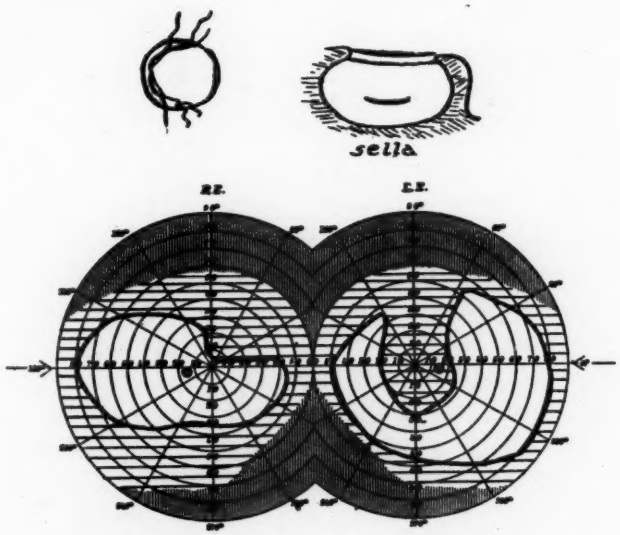

Fig. 4.—Drawings and visual fields in case 3.

the internal carotid artery, and ascribed the marginal excavation to injury of the optic nerve fibers from pressure of the calcified vessels or to the development of areas of softening from closure of the nutrient blood vessels.

The x-ray photographs in my series of cases were taken by Dr. H. A. Goalwin and Dr. S. Fineman, and demonstrate calcification of the cerebral basal vessels.

The photographs are not easy to take; the changes are often faint, difficult to demonstrate and disappointing (Schüller) because the bones are osteoporous and the patients are mostly old and do not hold well.

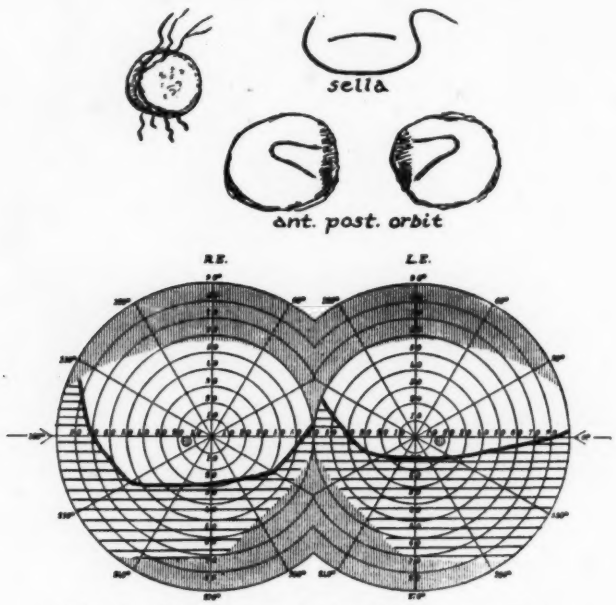

Fig. 5.—Drawings and visual fields in case 4.

As lime deposits occur in the hypophysis or in the diaphragm of the sella, Thiel said that stereoscopic photographs are essential to determine the necessarily extrasellar shadow of the internal carotid.

Dr. M. C. Sosman, of the Peter Bent Brigham Hospital, does not think that the calcification in the arteries explains the changes in the optic nerves. He quoted Schüller as stating that the changes are due to thickening of the arterial wall inside the optic canal which may occur with or without calcification and that the calcification observed simply gives the general idea of the condition of the patient's basal arteries.

In addition to the x-ray findings the following cases present other peculiarities which suggest a definite disease entity differing from the usual glaucoma, and a consideration of which will follow the brief report of the clinical findings.

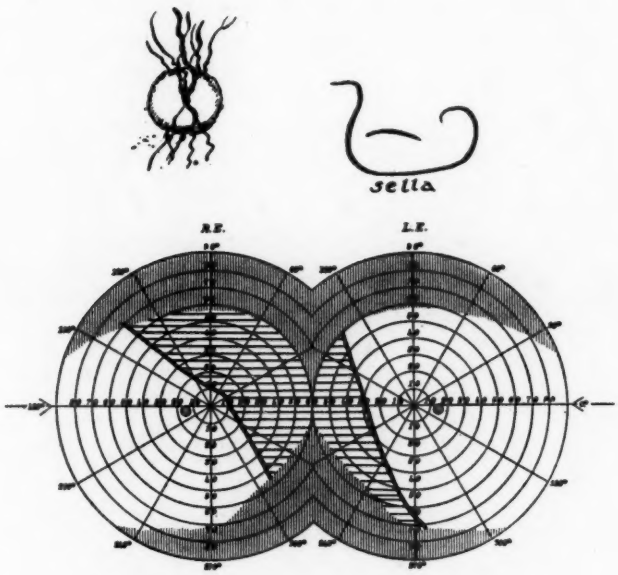

Fig. 6.—Drawings and visual fields in case 5.

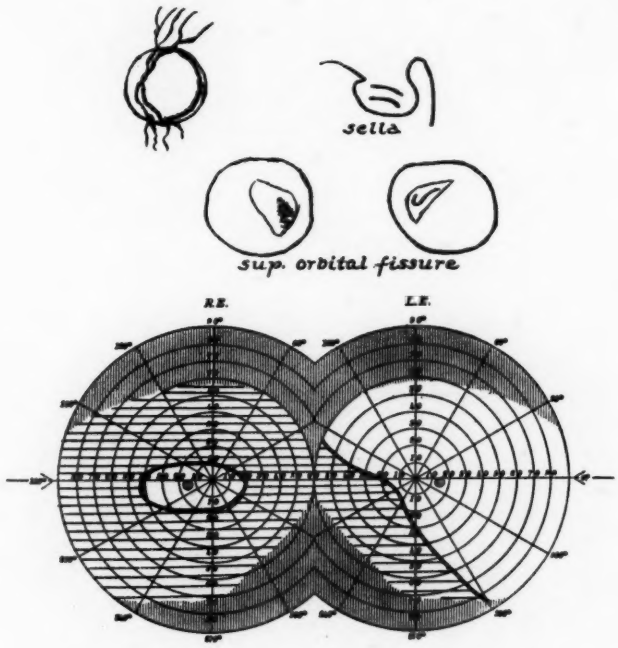

Fig. 7.—Drawings and visual fields in case 6.

REPORT OF CASES

CASE 1.—In B. R., a man, aged 60, there had been gradual loss of vision to: R. —12 = 20/70; L. —10 = 20/200. The field consisted in a very small central field and an area in the upper field. Tension was 18 in the right eye and 16 in the left. Optic atrophy was present. Roentgen examination disclosed sclerosis of the internal carotid and posterior communicating arteries.

CASE 2.—S. Y. F., a man, aged 75, had experienced gradual loss of vision to: R. = 8/200; L. = 10/200. A diagnosis of glaucoma had been made. The right field showed a contraction in the upper half, and a preserved area in the temporal half. Tension was 14 in the right eye and 16 in the left. There was optic atrophy with a depressed cup. As a nuclear cataract was present a bilateral iridectomy

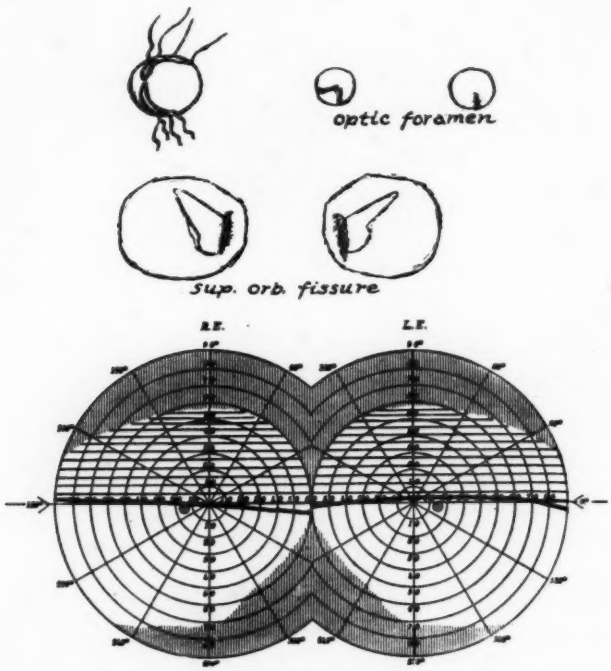

Fig. 8.—Drawings and visual fields in case 7.

was done. Roentgen examination revealed calcification of the posterior communicating arteries and in the optic foramen.

CASE 3.—E. S., a woman, aged 56, had noted loss of sight for several years. A diagnosis of glaucoma was made. With glasses vision was: R. = 20/40; L. = 20/70. Tension was 26 in the right eye and 22 in the left. A deep cup with atrophy was noted in both. There were nasally displaced vessels. Roentgen examination showed calcification of the posterior communicating arteries and partial calcification of the internal carotid arteries.

CASE 4.—J. A. D., a woman, aged 53, had been under treatment for glaucoma. Vision was: R. = 20/40; L. = 20/70. Tension was 26 in the right eye and 31 in the left. A field defect was noted in both lower halves. There was optic atrophy with a shallow cup. Roentgen examination showed calcification of the internal carotids.

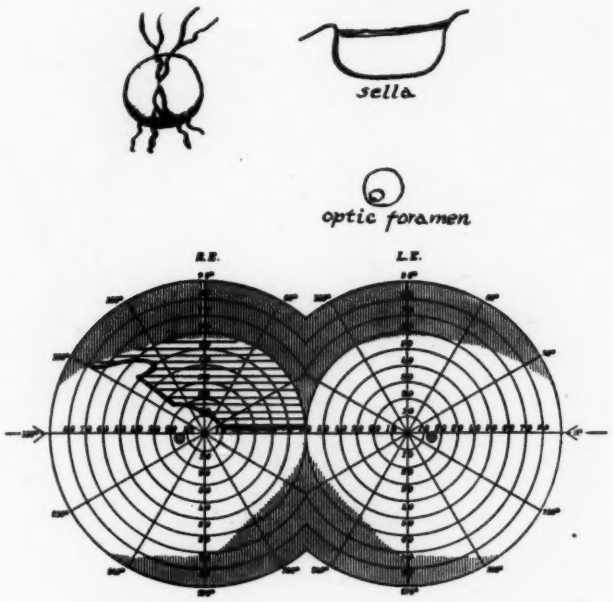

Fig. 9.—Drawings and visual fields in case 8.

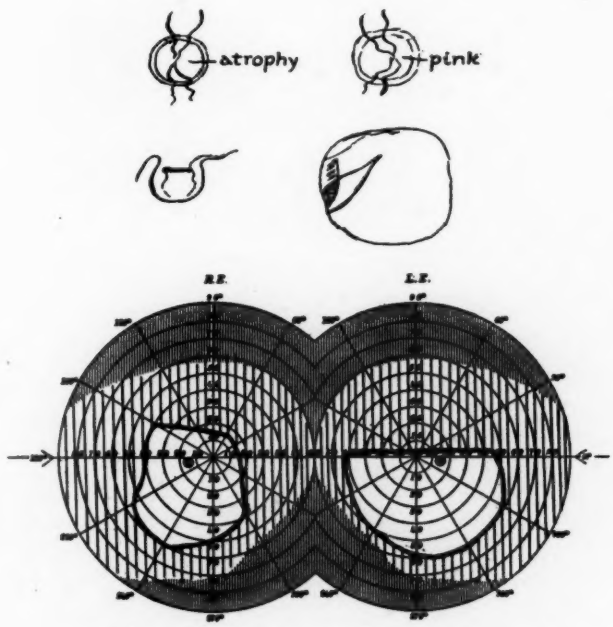

Fig. 10.—Drawings and visual fields in case 9.

Case 5.—C. F. R., a man, aged 68, had been under observation on account of optic atrophy with a cup and nuclear cataract. Vision was: R. = 20/70; L. = 20/200. Tension in the right eye was 26; in the left, 22. A cataract in the right eye was extracted in capsule. On Feb. 11, 1931, vision was 20/70 in the right eye with a glass, and 2/200 in the left (nuclear cataract). Roentgenograms showed calcification of the basal vessels.

Case 6.—In D. A. H., a woman, aged 63, sight had failed recently. Vision was: R. = 20/30; L. = 20/30. The fields were concentrically contracted; in the left eye there was a peripheral defect down and in. Tension was 18 in each eye. Marginal cup and atrophy were noted. Roentgenograms showed calcification of the internal carotid in the sella. Anteroposterior views revealed: on the left the

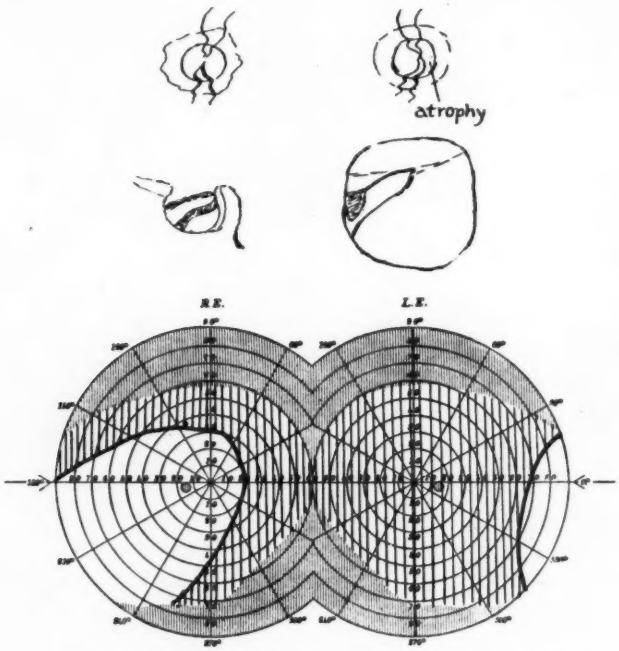

Fig. 11.—Drawings and visual fields in case 10.

shadow of a tortuous calcified internal carotid artery; on the right a thin line representing the ophthalmic artery.

Case 7.—J. C. S., a woman, aged 74, had been treated with pilocarpine drops for the past four years for glaucoma. The left eye had been trephined. Vision was: R. = 8/200; L. = 6/200. Tension was 22 in the right eye and 10 in the left. A defect was present in both upper fields. Optic atrophy with cupping was noted. The right eye showed nasal displacement of vessels; the left, a depressed cup. Roentgenograms revealed calcification of the ophthalmic arteries and internal carotids.

Case 8.—V. M., aged 69, had vision of 20/20 in the right eye, with a field defect in the upper half. Optic atrophy was limited to the lower margin, which was cupped. Tension was 22 in the left eye. There was central choroiditis. Roentgenograms revealed calcification of the posterior communicating arteries and a calcified blood vessel to the inner side of the right orbital fissure suggestive of the ophthalmic artery.

CASE 9.—E. B. S., a woman, aged 60, had been treated for glaucoma, and an operation was considered. Vision was: R. = 20/30 —; L. = 20/20 —. Tension was 16 in each eye. The fields showed concentric contraction and a defect above. There was optic atrophy with a central cup. Roentgenogram examination disclosed calcification on either side of the sella. A shadow was seen in the nasal extremity of the left superior orbital fissure.

Summary of Observations

Case	Sex	Age	Vision	Tension	Field	Fundus	Roentgen Findings: Calcification of
1	M	60	R. —20/70 L. —20/200	R. 18 L. 16	Central and upper area preserved; defect in both lower halves	Optic atrophy	Internal carotid
2	M	75	R. 8/200 L. 10/200	R. 14 L. 16	Right: defect in upper half Left: defect in nasal and upper half	Optic atrophy with cup	Internal carotid and ophthalmic artery
3	F	56	R. 20/40 L. 20/70	R. 26 L. 22	Right: defect in upper and nasal half Left: defect in upper and central half	Optic atrophy with cup	Posterior communicating artery and internal carotid
4	F	53	R. 20/40 L. 20/70	R. 26 L. 31	Defect in both lower halves	Optic atrophy with cup	Internal carotid
5	M	68	R. 20/70 L. 20/200	R. 26 L. 22	Right: defect in upper and nasal half Left: defect in nasal half	Optic atrophy with central cup	Internal carotid
6	F	63	R. 20/30 L. 20/30	R. 18 L. 18	Right: central area preserved; defect in upper half Left: defect in nasal and lower half	Optic atrophy with central cup	Internal carotid
7	F	74	R. 8/200 L. 6/200	R. 22 L. 10	Defect in both upper halves	Optic atrophy with central cup	Internal carotid and ophthalmic artery
8	M	69	R. 20/20	R. 22	Right: defect in upper half	Optic atrophy with marginal cup	Posterior communicating and right ophthalmic artery
9	F	60	R. 20/30— L. 20/20—	R. 16 L. 16	Concentric contraction below and defect in upper half	Optic atrophy with central cup	Internal carotid and posterior communicating
10	M	73	R. 20/20— L. 3/200	R. 18 L. 26	Right: defect in nasal and upper half Left: small temporal area of preservation	Optic atrophy with marginal cup	Internal carotid and posterior communicating

CASE 10.—A. G. B., a man, aged 73, had had loss of vision for two years and was using pilocarpine. Vision was: R. = 20/20 —; L. = 3/200. In the right eye there was a shallow marginal cup; in the left, a cup with optic atrophy. Tension was 18 in the right eye and 26 in the left. Examination of the fields showed contraction nasally and above in the right eye and a total defect in the left, except for a temporal segment. Roentgen examination revealed a calcified contour of the floor of the sella and a vertical shadow in the left superior orbital fissure.

A summary of the foregoing cases is given in the table.

COMMENT

A survey of these ten cases shows that the sexes were equally divided and that the ages varied from 53 to 75. Vision was often better than the field or ophthalmoscopic findings indicated. The field changes had a tendency toward altitudinal defects and were not like the usual changes in glaucoma. Tension varied between 14 and 31, averaging 20. The optic nerve changes were pronounced optic atrophy with central or marginal cupping. Roentgen examination showed calcification of the internal carotid, posterior communicating and ophthalmic arteries. The general symptoms were those of a moderate general arteriosclerosis without particular cerebral manifestations. Some of these cases were followed for several years, and the course was frequently stationary, or progress was very slow. An operation for glaucoma was performed in two cases without any influence on the course of the disease. These clinical findings, among which the optic nerve changes, the low tension, the peculiar fields and the nonprogressive character are peculiar, show that this condition differs from glaucoma and that an operation need not be considered. The roentgen findings, while as yet not confirmed by anatomic examination, suggest a possible cause.

ABSTRACT OF DISCUSSION

Dr. T. B. Holloway, Philadelphia: I should be inclined to attribute the sclerosis to a vessel that Dr. Knapp did not mention, namely, the anterior cerebral artery, which would be the one that would be most likely to give the altitudinal defect shown.

Dr. Arnold Knapp, New York: I think that Dr. Holloway's criticism, if it is a criticism, is well in order. I did not for one minute assume that the only vessels that were calcified were those I mentioned. The ones I mentioned are those that can be demonstrated by roentgenograms. I do not think that one can demonstrate the anterior cerebral artery.

The purpose of my contribution was to show that a condition occurs in elderly people which has all the symptoms of glaucoma, but without tension. The treatment is difficult to decide on, particularly as to the question of operation.

PURPURA HAEMORRHAGICA OF THE SCHÖNLEIN-HENOCH TYPE

REPORT OF A CASE

J. SHELDON CLARK, M.D.
FREEPORT, ILL.

My attention was called to the literature on this subject by an experience in May and June, 1930. I was called in consultation to see a patient because of a severe inflammatory reaction in both eyes, which had then existed for six days before her entrance into the hospital.

There are so many manifestations of purpuric disease that one hesitates in a given case to be certain of the classification. Osler spoke of the many characteristic lesions of the skin in cases of purpura: all varieties of purpura; wheals and edemas; erythema with or without swelling, and necrotic areas due to localized infiltration of the skin. When there are symptoms in the joints, the most common joints to be affected are the ankle and knee, and the pain can be most excruciating. Involvement of the kidney is often quite serious, and in the case reported, was accompanied by an anuria lasting for several hours, so that life was despaired of, the patient becoming quite drowsy and for a time unconscious.

Only a single examination of the blood was made, which showed: hemoglobin, 80 per cent; erythrocytes, 4,720,000; leukocytes, 16,000; red blood cells normal as to shape and size, and normal blood platelets. A Kahn test of the blood was negative.

In a historic review by Goldstein [1] I gleaned the following: He ascribed to Willan [2] (1808) the description of a case of purpura occurring in a woman, 36 years of age, who ran a course of abdominal colic, vomiting, a bloody diarrhea, painful and swollen joints and cutaneous lesions such as purpura, urticarial wheals and angioneurotic edema. To Schönlein [3] goes the credit for describing and giving due importance to symptoms of the joints in cases of purpura characterized by painful, tender and swollen joints. In 1874 Henoch [4] reported four

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Read before the Section on the Eye, Ear, Nose and Throat, Illinois State Medical Society, Springfield, Ill., May 18, 1932.

1. Goldstein, Eli: Schönlein-Henoch's Purpura, M. Clin. North America **12:** 869 (Nov.) 1928.
2. Willan, R.: On Cutaneous Diseases, London, J. Johnson, 1808, p. 457.
3. Schönlein, J. L.: Allgemeine und specielle Pathologie und Therapie, Herisan, Lit-Compt., 1832, vol. 2, p. 68.
4. Henoch: Ueber eine eigenthümliche Form von Purpura, Berl. klin. Wchnschr. **11:**641, 1874.

cases of purpura, and in addition to pains in the joints described by Schönlein and the purpura, he mentioned other symptoms, such as vomiting and colic; he later observed that there was an accompanying nephritis with hematuria. This brings the knowledge of the disease to about that of the present time.

Others are of the belief that purpura simplex, the rheumatic type and those with generalized hemorrhage are simply varying degrees of intensity rather than clinical entities. Variations in the bleeding time have been noted; some find it normal while others note an increase. It was normal in the present case.

Differentiation Between Schönlein-Henoch's Purpura and Purpura Haemorrhagica

	Schönlein-Henoch's Purpura	Purpura Haemorrhagica
Constitutional symptoms	Malaise, headache, anorexia, coated tongue, fever	Few; no fever unless secondarily as result of complicating infection or profound anemia
Special features	Urticaria, erythema, edema, joint pains and swelling, abdominal colic, vomiting, melena, hemorrhagic nephritis	Absent; melena without colic and hematuria without nephritis do occur
Cutaneous lesions	Petechiae, purpura, urticaria, erythema	Ecchymosis, extensive suggillations, purpura
Localization	Extremities preferred, especially near the joints; head usually spared	Irregular, frequently on head
Mucous membrane hemorrhages	Moderate bleeding from gastrointestinal tract; otherwise rare	Frequent epistaxis; stomatorrhea; uterine, vesical, gastrointestinal and renal bleeding may be extensive
Bleeding time	Normal	Increased
Clotting time	Normal	Normal
Clot	Retractile	Nonretractile
Morphology of blood	Slight leukocytosis, occasional eosinophilia	Tendency toward leukopenia and relative lymphocytosis
Platelets	Generally normal; may be increased or moderately diminished	Marked thrombopenia with giant forms
Tourniquet test	Positive	Strongly positive with large ecchymosis

As to the differential diagnosis, Goldstein quoted Frank, Glanzmann, Pfaundler and von Seht as to the differentiation of Schönlein-Henoch's purpura from purpura haemorrhagica, both from the blood and clinical aspects, and gave the accompanying table.

REPORT OF CASE

Mrs. A. B., 62 years of age, was seen at the Deaconess Hospital, May 26, 1930. Before being admitted to the hospital this patient had been ill for a period of six days. I saw her in consultation on her first day in the hospital, where she remained until July 7.

She complained of excruciating pain in both eyes, as well as severe pain in her arms, hands, legs and feet. There was a deep beefy-red injection of the sclerae of both eyes which had become affected simultaneously. A general uveitis seemed to be present; there was a plastic iritis with plastic exudates and some blood in the

anterior chambers. A severe keratitis was also present, and the cornea of each eye had a dirty-gray appearance. The iris was bound down in each eye and could not be affected by heroic doses of atropine used in solution, then in ointment and finally in powder form. At no time could the fundus be seen with any degree of satisfaction. The eyes were extremely painful. There was a much swollen condition of the extremities, which were covered with large areas the color of port-wine or red plush upholstering; many of these areas later broke down and became necrotic in character, and large sloughs occurred, which added to the difficulty in caring for the patient. There was a sensation of heaviness in the hands, feet, legs and arms. The patient remarked that she had been suffering from pain in the feet and ankles, accompanied by swelling, for a year or more. Now the pain was of an excruciating character, and even the slightest movement was extremely painful.

In a fairly active practice of twenty-five years, together with a residence in one of the larger special hospitals of this country and several months spent in observation of the clinics of the Old World, it had never been my opportunity to see a case of this description, and I report it as something of clinical interest.

History.—The mother died of heart disease at the age of 79; the father, of a paralytic stroke at 81.. Several brothers and sisters were robust and living. The patient stated that seventeen years before she had an attack of neuritis affecting mostly the muscles of the neck and back, also the legs and feet; the limbs, feet and hands were swollen. This attack lasted between two and three years, during which time she had to use crutches. There was a great weakness of the ankles and they would not bear her weight(about 200 pounds [90.7 Kg.]). She then walked with a cane for a year or so longer. For the next fourteen years she was greatly troubled with neuritis and could usually foretell oncoming stormy weather.

In 1916, according to the patient, "radium solution" was used in the veins on four different occasions. On May 21, 1930, the present illness began with a chill, and was diagnosed as summer "flu." There was a temperature of 102 F. The patient entered the hospital on May 26; she was moderately delirious, and had a great deal of pain in the eyes, of which much complaint was made. Previous to entering the hospital she noticed that she could see imperfectly; she complained that everything looked like a fern leaf, and that the faces of her friends had a calico-like appearance. On May 24, blotches appeared on the dorsal surface of the feet, hands, legs and fore-arms as well as on the shoulders and buttocks.

Physical Examination.—Examination showed a rather large, obese woman, whose tonsils were large and gave evidence of past infection, but were not acutely inflamed. There were many purpuric areas on the skin of the feet, legs, thighs, buttocks, fingers, back of the hands and forearms. The face, chest and abdomen were singularly free from purpuric blotches. The feet and hands were swollen and the joints were extremely tender and painful; movement caused excruciating pain.

Course.—The woman had been treated for a week or more in the country. When I saw her she had severe pain in the eyes, with a severe iritis and keratitis, and the posterior surface of the cornea was covered with a grayish, creamy exudate that occurred in streaks. Besides the exudates in the anterior chamber of both eyes there were some streaks of hemorrhage. The iris of each eye was fixed and could not be dilated, although atropine was used most vigorously with the hope of securing mydriasis, but to no purpose.

Benedict[5] stated: "The ocular signs of purpura are few. Rarely the lids are the seat of hemorrhagic deposits, although hemorrhages into the optic nerve and

5. Benedict, W. L.: Schönlein-Henoch's Purpura with Intra-Ocular Hemorrhage and Iritis, J. A. M. A. **95**:1577 (Nov. 22) 1930.

retina have been noted, as well as optic atrophy. Motolese [6] saw bilateral papillitis, with alternating convergent strabismus, from rheumatoid exanthematous purpura. The patient was a child, 3 years of age. The day after the onset of fibrile symptoms purpuric patches appeared on the skin of the abdomen and limbs and convergent strabismus developed. In one eye hemorrhages were associated with the papillitis."

A number of writers speak of having observed small petechiae on the sclera and conjunctiva in cases of purpura. Retinal hemorrhages and conjunctival hemorrhages are frequently mentioned, but in no case in the available literature which came to my hands, save one, were the ocular symptoms reported at all commensurate with those observed in this case.

This patient was under observation for a period of forty-three days, during which time the disease rose to its acme, there being great distress in the joints of the hands, feet, knees and thighs. It was almost impossible to turn her, and in spite of vigorous use of salicylates, foreign protein and symptomatic treatment the condition seemed to go on to its own termination, a gradual restitution taking place.

In March, 1931, I removed the patient's right eye on account of persistent pain and continued degeneration to the point of lack of either perception of light or projection in either eye. She is now quite happy in her work of basket weaving, for which she has to thank the Illinois State Board of Health and its work of teaching the blind some form of occupation, without which life would be unbearable.

The eye was sent to Dr. Sanford Gifford, professor of ophthalmology at Northwestern University Medical School, whose report is as follows: "The iris, ciliary body and choroid all show a marked congestion. The veins are full of blood and there is round cell infiltration about a number of veins in the iris, with some diffuse round cell infiltration in the iris stroma and some blood cells free in the uveal stroma, but no large hemorrhages in the section examined. The choroidal arteries show marked thickening of their walls. In the ciliary body is a large focus of round cell infiltration with a number of free red cells. Next to this is some new connective tissue containing thin-walled vessels. Apparently this represents a site of a larger hemorrhage which is being absorbed and replaced by connective tissue. The ciliary processes are edematous and hyperemic. This section is not cut through the pupil, so the chamber angle cannot be described. I would appreciate a little more history on this case, and we will send you a complete report when our celloidin sections are run through; this is the best we can do in paraffin."

After receiving the foregoing report a second one was sent me by Dr. Gifford, which gave the pathologic changes through the anterior segment of the eye and which was made from a celloidin section: "This section goes through the pupil and shows that the anterior chamber is almost obliterated. The iris is bound to the cornea and the lens capsule by newly formed connective tissue. The chamber angle on one side is completely closed; at the other side the canal of Schlemm is patent and there is a narrow anterior chamber. Just under the iris root at this side is a focus of fresh round cell infiltration. The cornea shows some infiltration near the limbus and edema of the epithelium. The iris is infiltrated with large mononuclears and a few polymorphonuclears. The lens shows some newly formed spindle cells under the capsule. The retina is completely detached. The choroid is much congested and shows some round cell infiltration. There is a dense cyclitic membrane behind the lens attached to the retina. There are some small hemorrhages in the ciliary body, and the small vessels are much dilated.

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6. Motolese, in Jackson, E.: Ophthalmic Year Book, Chicago, Ophthalmic Publishing Company, 1913, p. 245.

"*Summary.*—The picture is one of chronic iridocyclitis with a secondary glaucoma and retinal detachment due to the formation of cyclitic membranes. There has also been some recent active inflammation. There is nothing distinctive about the picture which suggests a reaction to a blood dyscrasia except the marked congestion of the vessels and hemorrhages which might be present in any severe uveitis. Apparently the uveitis was due to some form of infection, or the presence of toxic material in the blood stream."

In November, 1931, I removed the patient's tonsils, which showed evidence of chronic infection; she is of the belief that she has felt better since that time.

COMMENT

There was no history of familial tendency to blood disease obtainable in this case. The most important elements were the swollen and painful joints and the purpuric spots on the extremities and scapular and buttock regions. There was no tendency to excessive bleeding from the gums, nose or bowels. There was excessive tenderness over the abdomen, with some distention and a tarry appearance of the stools for several days.

This case was characterized predominantly by an arthritis with excessively swollen and painful joints of the feet, hands, arms and legs, with red plush-like hemorrhagic areas, in some of which necrotic spots developed. There were colic, vomiting and tarry stools, with a moderate fever. Within the first twenty-four hours ocular symptoms developed, which resulted in intra-ocular hemorrhage, iritis with a dense corneal opacification and loss of vision in both eyes. There was a general uveitis. In the previous attack, which was mentioned as occurring seventeen years before, there were no ocular symptoms. The patient seems, at the present time, well and happy in her work.

SOME ESSENTIALS AND SECURITIES WHICH STABILIZE OPERATIONS ON OCULAR MUSCLES

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On visiting different clinics, abroad and at home, and on interrogating various surgeons, one is struck by the fact that while there are many operations on ocular muscles in existence, usually only one is used by each surgeon or clinic, or one routine is practiced and advocated for the correction of most of the types of squint, and that this selection is based more on the surgeon's leaning toward a favored operation than on the consideration of that which is best adapted for the particular type of squint which exists.

It is my endeavor in this article to emphasize the necessity of a broad survey of securities which stabilize operations on muscles and the need of utilizing all the means which ophthalmology puts at one's disposal for the correction of muscular anomalies.

The following phases of the subject seem to be of special importance.

SECURITY OBTAINABLE BY METHODS TAKING A BROAD VIEW OF CAUSES OF SQUINT

It would hardly seem necessary to comment on such security in any way, were it not for the fact that in the literature on the subject one particularly favored cause and method of remedying it, as in the case of operation, is accepted by a writer to the exclusion of all other methods of equally proved efficiency.

One should include, of course, Donders' great teachings; the practice of fusion training and its means of accomplishment by the use of the Worth amblyoscope, the stereoscope and the more recent and ingenious cheiroscope of Maddox, etc., and also the use of atropine, occlusion and other devices will in many instances obviate the necessity of operation or be valuable aids before and after operation.

Moreover, the ascertaining of underlying pathologic conditions, palsies, muscular degeneration and congenital defects may point to the futility of long-continued therapy and also give a premonition of the difficulty that the surgeon will have in holding the correction if operation be undertaken, while again anatomic conditions, sometimes more difficult to diagnose on the surface, but amply demonstrated after expo-

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sure of the field of operation, frequently show clearly how the operation was necessitated. It may have been the fascial contractions, muscular hypertrophies, insertional anomalies, typical and atypical retraction syndrome, etc., that the late Dr. Alexander Duane [1] had in mind when he stated: "the lack of ability to perform fusion in these cases is not so much the cause of the squint as the result of it."

Wilkinson in his excellent review quoted a broad and well expressed view of causation by Reber: [2]

> I believe with Doctor Posey that there is much in anatomical peculiarity, whether in the build of the muscle or the insert of the muscle, or in orbital build in children with alternating strabismus. I believe the combined theory which will take into account the Donders theory of Worth's fusion faculty will account for practically all the cases except congenital palsies.

A broad understanding and thorough investigation of causation give the surgeon the necessary enlightenment as to procedure. Diligent investigation of these numerous causes must necessarily increase the percentage of corrections. It is the multiplicity in causation which contributes to that erratic residue of noncorrection which can be reduced but never altogether eliminated.

SECURITY BASED ON PROPERLY ESTABLISHED FOUNDATIONS OF SOUND COMPUTATION AND GRADATION

The symptom of deviation alone is frequently taken as the guide to operative procedure and gradation. When this is the case, it must necessarily lead to uncertainty of result. It is again the careful investigation of conditions which underlie the deviation that gives definite indication of what should be done and the selection of the best procedure to do it. Computation must include all the underlying factors. It is beyond the function of this paper to review all the symptoms which aid in making clear comprehensive computation.

Bearing on this question, however, there is no clearer or more practical summary of the indications and contraindications for operation on the lateral muscles than that of Dr. J. W. White,[3] of New York:

> In convergent strabismus, if the convergence near point is less than normal, also when the deviation for distance and near are about the same, if the interni are normal, but the externi are less than normal, an operation to increase the action of the externi should be chosen. For either a convergent, divergent or vertical anomaly, where a weakening of muscle is indicated, the operation of Recession is a more precise and safer procedure than simple Tenotomy.

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1. Duane, Alexander, in Fuchs: Textbook of Ophthalmology, ed. 6, Philadelphia, J. B. Lippincott Company, 1920, p. 89, footnote.

2. Reber: Pennsylvania M. J. **17**:602, 1915.

3. White, J. W.: Unpublished Lectures on Muscle Anomalies, New York, 1931.

As illustrative of these outlines in the guidance of procedure I can take two instances occurring in cases of the same deviation, yet requiring different operative procedures.

In the first instance I shall take an internal deviation of 30 degrees. The near-point of convergence is better than normal (less than 50 mm.). Deviation for the near-point is markedly increased over that for distance. Abduction sometimes falters before reaching the outer canthus.

In the second instance I shall take a case of the other extreme. The internal deviation is the same, that is, 30 degrees. But the near-point of convergence is found to be remote, 75 mm. or more. The deviation for near and distance is the same. Abduction is likely to be accomplished to the outer canthus without faltering.

These two cases of the same deviation show diametrically opposed clinical pictures, and I propose to outline what seems the logical treatment for each with the reasons for such treatment.

In the first case, after the patient has fixed on a small object, he can converge to a point at 50 mm. or less, and the deviation as measured in prism degrees for near is in excess of that for distance. The case shows a marked hypertension underlying the deviation. Such cases are frequently found. Most esotropias are of this type.

The externus, indeed, may be quite overpowered and incapable of abducting to the canthus. The musculature may be greatly in excess of the normal, highly tense and resistant to abduction as ascertained by traction on the eye by means of a strabismus hook or fixation forceps after the muscle has been tenotomized.

A recession is indicated as the primary procedure. If an advancement is done, it will, as a rule, yield little correction without the recession, and when the necessary 4 or 5 mm. recession is performed, the advancement, by adding greatly to the tension already existent on it, tends to destabilize the result unnecessarily.

Moreover, the primary recession may not only correct the deviation but restore the overpowered externus. The latter incident is frequently noticed. The recession, by reducing the tension of an overstretched externus, enables it to recuperate.

It is my own practice to make recession the primary procedure when tension is the predominant feature and advancement when it is not, for the following reasons:

Recession decreases the tension on both the operative and nonoperative side, and, contrariwise, advancement increases the tension on both. When recession is performed, the reduction in strength of the hypertensive muscle is brought about primarily by its relaxation, but with advancement the reduction in strength in the hypertensive muscle on the opposing side is brought about by the exerting or adding of hypertension.

In instances of esophoria when hypertension is the predominating feature, recession is a healthier procedure than advancement because of this feature. Take for instance the crude illustration of an elastic, the pulling power of which can be reduced by tension; elastic stretched out to the point of reducing its tension is not in a very strong condition, whereas elastic, the tension of which is reduced by a relaxation in the tightness of the stretch, is in a stronger and healthier condition than before. *Reduction by tension is that of advancement; reduction by relaxation is that of recession.* This principle in recession makes for the preservation of convergence.

Again, the weakening of the hypertensive muscle by recession is much greater in contribution by relaxing the muscle than by stretching it through the agency of hypertension. In marked hypertension of an internus an advancement on the opposite side will primarily yield little correction, but in the same condition, with few exceptions, recession will yield liberal correction as a primary procedure in this type of case, and the foregoing statement explains the high average of correction obtained by it.

It should not be overlooked that in many instances this principle of elasticity and contractile strength just mentioned is exhibited after recession in the instance of overstretched and overpowered muscle, incapable of abduction, which resumes its function after tension has been removed.

The crux of the matter lies in the fact that logically the reduction in strength of a hypertensive muscle can be accomplished much better by inducing true relaxation than by inducing hypertension, and that clinically this is borne out by the higher degree of correction obtainable and the uniform percentage of actual corrections.

In the second case of the same internal deviation of 30 degrees, when the eyes fix on a small object gradually made to approach, convergence cannot be accomplished or maintained to a point nearer to the eye, say, than 70 mm. or more. Thus the convergence near-point is remote, and the deviation as measured by prism degrees for near is not in excess of that for distance, as it was in the first case. This second case shows a clinical picture less frequently found, of internal deviation with relatively weak convergence, and contradicts the somewhat prevalent idea that deviation is always accompanied by supermuscular power or enervation on the deviating side.

If one relied exclusively on deviation for a guide, a recession would be considered by many the logical procedure. But this in reality is contraindicated. A primary advancement, resection or kindred operation would probably correct a large portion, if not all, of this deviation.

The internus, if possible, should be left alone, for it would be a mistake to weaken it further and thereby invite destabilization by overcorrection and further weaken convergence.

An advancement or kindred operation is most certainly indicated, for the great attribute of advancement is to restore tension and thus add strength to a relaxed muscle. The hypertension produced on the internus by advancement on the opposite side (giving a smaller contribution to correction than that obtained by the relaxation of the recession) will be quite sufficient for the requirements in a case of this kind.

These two examples illustrate how a stereotyped procedure, practiced without due interrogation of conditions underlying the deviation, may destabilize the result, and how, by relying on deviation alone, which in these cases was the same, it is possible to make the mistake of using the contraindicated procedure.

Between these two extremes there exist varying grades of deviation and varying grades of hypertension and relaxation, and the procedure will be adjudicated by the light which careful computation affords. The large majority of esotropias can, however, be classified in the hypertensive or first type, and for them recession should be the primary procedure. In the majority of exotropias advancement or a kindred operation as a primary procedure is indicated.

Practical deduction as to the gradations of operative effect can be made from the facts mentioned, and their relative potency may be utilized and applied to advantage. One should apply surgical correctives with the same care with which the artist applies his pigments.

Again, just as one may destabilize results by reliance on deviation alone as a guide to surgical procedure, so it will lead to destabilization if one relies purely or wholly on tabulated forms for gradation without taking into consideration the computed conditions underlying deviation. The same principle which guides the operator in the selection of operation should point the way to gradation.

The tabulated forms on gradation published by experienced operators differ, and properly so. They are valuable in that they are taken from averages, but when subjected to the scrutiny of careful computation in individual cases, they will often have to be revised and completely reversed.

For example, in the literature, the correction of 30 degrees mentioned by Campbell and Alexander [4] and Meller [5] as the maximum for an advancement of the externus to the sclerocorneal margin, with a resec-

4. Campbell, E. K., and Alexander, G. F.: Operative Treatment of Concomitant Strabismus, Lancet **1**:1466 (June 1) 1912.

5. Meller: Ophthalmic Surgery, ed. 3, Philadelphia, P. Blakiston's Son & Co., 1923, p. 142.

tion of 7 mm. of tendon, will often be reduced to zero if a large hypertensive muscle exists on the opposing side. Otherwise the advancement can accomplish the 30 degree correction.

Again, a recession of 4 mm. on the externus (1.5 mm. behind the equator) may yield no correction if underlying convergence is noticeably insufficient, but may result in marked overcorrection if evidence of reserve muscular power is exhibited on the internal side.

The principles which guide the operator in the correction of lateral deviations are largely applicable to the correction of the vertical. The correction of a vertical deviation will often correct a lateral squint. For an intimate and an authoritative outline of this part of the subject, I would refer the reader to an article by White.[6]

I would conclude in the following summary on computation some of the guides that I have found helpful in my own work:

1. Exclusive reliance on deviation alone should not be the basis for determining operative procedure, but deviation as a guide should always be supplemented by careful consideration of the underlying conditions.

2. Internal deviation with relatively weak interni accompanied by a remote nearpoint of convergence contraindicates recession as a primary operation, and points to an advancement as the selection.

3. Contrariwise, an internal deviation with a tense hyperstrong converging system, with a normal or better than normal (50 mm. or less) convergence nearpoint, would indicate recession as the primary procedure.

4. Advancement weakens muscular action on the deviating side by increasing tension on it. Recession weakens muscular action by decreasing tension.

5. Advancement restores or increases muscular action on the weak or advanced side by the acquisition of tension. Paradoxically, recession may restore muscular activity on the weak or opposing side by reducing tension on an overstretched muscle.

6. The primary contribution of an advancement to correction of internal deviation with hypertensive strong muscle is comparatively small. The primary correction of the same type by a recession is usually large and uniform.

7. Recession is limited to 5 mm. on the internal side and 3 mm. on the external.

8. Advancement (external) can be carried to a much higher gradation than recession, but its relative contribution to correction is much less when estimated in millimeters.

9. When computation points to the combined procedure as the selection, a good clinical gradation is 1 mm. of recession to 2 mm. of advancement.

10. The higher the degree of gradation, the greater the tendency toward destabilization.

11. High degrees of deviation are most safely operated on by distributing the effect to both eyes.

12. If resection can be confined to the tendon, it makes for better muscular balance.

13. The final result is best conserved by not attempting to do too much at one sitting.

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6. White, J. W.: Hyperphoria: Diagnosis and Treatment, Arch. Ophth. **7**:739 (May) 1932.

SELECTION OF OPERATIVE PROCEDURE BEST ADAPTED TO CONDITION EXISTING

While one has a choice of operative procedures there is undoubtedly a tendency to cling to one operation for all conditions, perhaps, due to partisanship to a traditional scheme of operation taught one in early student days, or to partisanship by reason of the origin of an operation in a certain hospital or city; or again, as often quoted, because the operator feels that he can accomplish most with the operation with which he is most familiar. These reasons are true and wise only when the procedure is of the type to meet the corrective exigencies of the individual case, and when one operation is used in every instance it must often be done irrespective of its adaptability to conditions.

The more subtle reasons for special procedures have been discussed under computation, but there are some classifications in operation making for greater or lesser effect that one can use to advantage.

Surgical evaluations of advancements and kindred operations, tenotomies and the entity of recession can be made to advantage.

Types of Advancement.—1. Those operations which place the muscle or tendon and end in front of its insertion (true advancement), which in turn can be divided into: (*a*) advancement in front of the insertion without resection of muscle or tendon; (*b*) advancement in front of the insertion with resection of the tendon alone, and (*c*) advancement in front of the insertion with resection of both muscle and tendon.

2. Operations which place or leave the end of the muscle at its normal insertion (resection and kindred operations), which can be classified as: (*a*) operations which place or leave the end of the muscle at its normal insertion with resection of the tendon alone, and (*b*) operations which place or leave the end of the muscle at its normal insertion with resection of both tendon and muscle.

Advancement possesses potential possibilities for correction in excess of resection and kindred procedures, and may well be used when higher corrections are required.

I know that some question this excess, and state that it gives no more correction than resection, the reasoning being that the muscle or tendon becomes firmly adherent to the sclera on that portion anterior to the normal insertion, and therefore the muscle must necessarily function from the point of normal insertion. This is not borne out clinically and can be contradicted in several ways.

The eye, when it swings out to correction, may lose part of the contact arc, so that the muscle does in reality function from a point in front of the normal insertion.

There is another reason, an anatomic one, possibly more convincing. The muscle is invaginated and fibrously enveloped by the deep and superficial layer derived from the capsule as it splits it. The fact that it forms an extended underattachment does not prevent the muscular fiber from still functioning within encapsulation.

Resection, tuck and kindred procedures may well be used when lesser gradations are required. It is an advantage to have the muscle functioning from its normal insertion. I use the term "kindred procedures" to include the O'Connor cinch operation.[7] One of the attributes which appealed to me on studying O'Connor's paper was the faculty that it possesses of doling out the desired effect at the time of operation.

We have a fairly wide range of gradation in the selection of operations of the advancement type, which, if used judiciously, will serve to stabilize results.

Tenotomies.—There are some outstanding impressions which one obtains from the perusal of the history of tenotomy. Distinctive among these is the necessity for its use, the desire of the surgeon to utilize it and the effort of the surgeon to stabilize it.

It is a safe statement, and one corroborated by any surgeon who relied on the procedure in the days before advancement had established itself, that it gave a goodly return of satisfactory and well held corrections, and if it had not evidenced its sometimes unstable and erratic return, secondary deviation and caruncular retraction, it would not have been relegated to the place of a secondary procedure, which it largely occupies today.

In the early days, very free tenotomies and myotomies were performed, and the operation fell into disrepute. Critchett[8] was possibly the first to stabilize tenotomy by calling attention to reckless dissection. Many operations followed which had in view the increasing of its safety. The restrain suture was an excellent procedure. Stevens introduced his graduated tenotomy. His was a gradual graded, curbed tenotomy, sound in principle but unfortunately slow in accomplishment. In his hands it was probably one of the most secure methods ever practiced, though it was greatly depreciated in his day for reasons for which Stevens was not responsible.

Cross-cut and lengthening tenotomies were advocated. They produced only a moderate effect and most of them left the muscle like a mutilated attenuated string. The popular tenotomy of today is what is known as a "guarded tenotomy." It should be depreciated only when it is improperly performed. Its principle is conservative dis-

7. O'Connor, Roderic: West. J. Surg. **39**:670 (Sept.) 1931.
8. Critchett: Lancet **1**:507. 1855.

section. Its success depends on the anatomic and tensive conditions. If they permit, it will accomplish what is desired and it will hold the correction. It is often handicapped to a certain extent by the hypertension placed on the muscle by a previously performed advancement; also, by reason of a hypertensive and hyperstrong musculocapsular condition, the guarded tenotomy of necessity becomes a "cut until effect is obtained tenotomy" which, in turn, may overstep conservatism and become a free tenotomy with its attendant evils, the muscle being turned loose to find its own nonprescribed resting place behind the equator.

Entity of Recession.—The advent of recession has changed much of the fortunes of tenotomy, and added much to its stability. This has been attributable largely to the demonstration of the safety of scleral suturing, scleral fixation, equatorial delineation, conservative dissection and careful computation. For the application of these principles, I would, to save time, refer to my recent article, "The Surgical Entity of Muscle Recession." [9]

I would state that, in addition to the points mentioned in that former paper, recession has another advantage which has not been emphasized, viz: the possibility of doling out the effect. In fact, it has been stated as a disadvantage that with recession if computation and gradation should go amiss, and an overcorrection or undercorrection result, it cannot well be remedied at the time of operation. This, however, is not the case.

Take for instance a patient under local anesthesia, when the combined procedure is used. The advancement has preceded the recession. After the central recession suture is placed, the correction should be viewed by getting the patient to fix. If parallelism is obtained, the wing recession sutures may be placed in line with the central suture as previously computed.

If it is desired to increase a recession effect, the wing sutures may be sclerally fixed behind the plane of the central suture. If a diminished recession effect is desired, the wing scleral sutures may be placed 1 or 2 mm. in front of the plane of the central suture.

Thus the recession can be doled out to meet the need of the case.

Among the outstanding general facts which the work of recession has taught are:

1. The weakening of a strong internus can be better accomplished by primarily and truly relaxing it by recession than by primarily imposing hypertension on it, that is, stretching and overcoming it by inducing tension from the pull on the opposite side.

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9. Jameson, P. C.: The Surgical Entity of Muscle Recession, Arch. Ophth. **6**:329 (Sept.) 1931.

In other words, the utilization of true relaxation, rather than the induction of hypertension, as the means of reducing muscular strength is desirable. The relaxation of the former, i. e., direct relaxation, will contribute much more correction (diminution in strength) than that of the latter, and will be fully as well protected if the principles of recession are practiced.

2. In cases of esotropia with demonstrable hypertension, a primary single or bilateral recession will give an extraordinarily high and uniform return of correction, probably the highest in any single or combined procedure.

The great sensitivity to surgical intervention on the internal side, endowed as it is with "exalted enervation to convergence," will never be eliminated. But recession, by reason of the safeguards already mentioned, has placed this surgical sensitiveness under much greater control, and renders the utilization of this 5 mm. area, which offers by far the largest contribution to correction, much more safe and secure.

I can state unequivocally that the value of tenotomy has been greatly increased both as a primary and as a secondary procedure, and that many of the causes of unsatisfactory and erratic returns of correction have been eliminated.

SECURITY OBTAINED BY THE PRACTICE OF LIGATURED SUTURES

The suture arrangements used in advancement and recession have much in common, and there are few writers who do not make the comment that it is possible for the operation to give way and for the sutures to slip. Indeed this possibility is sometimes cited by the advocates of other types of operations as a weakness if not a condemnation of advancement and resection. And this may be not without foundation, for if the prevalent arrangement is analyzed it is hardly that which a practiced sailor would select when desiring to make fast an expansive band of fiber on which marked tension was exerted.

The common use of the single through-and-through wing sutures supplemented by a double suture looped on one side, generally the under side alone, when viewed from the anatomic construction of the end of a muscle and the tension placed on it have always seemed to me to be the weakest feature of these types of operation. If one desired to cut or fray a band muscle one could not do so much better than by drawing a taut silk suture between its fibers.

Reasoning in this way, although the tension on a recessed muscle is slight as compared with advancement, I have always looped my central suture on both surfaces above and below, so that when it was ultimately tied, it was engaged in a surgical knot which held in its bite a bundle of muscle fiber which could not slip without taking part of the end of

the muscle with it. Strangulation exhibited by reaction or necrosis by inflammatory product has never resulted.

For the last few years I have applied the ligature principle to every advancement, resection or recession on which tension was exerted, and I am confident that the maximum security from slipping is obtained and that this is a valuable adjunct to operations on muscles.

The ligatured sutures are simply introduced. Single needle-armed sutures are used, and three loops or two if preferred, similar to those used in the Reese operation, are picked up and the enveloped bundles ligated. This can be duplicated at the insertion of the muscle, so that there is a system of opposed ligated sutures, one row engaging the end of the muscle and the other row at the insertion. To bring the end of the muscle up to the insertion or the sclerocorneal margin, these suture strands are in turn tied together, making thus a triple ligation. The suture needles can pick up conjunctiva before the tie.

The knots naturally are greater in volume and two thirds of this volume projects on the surface. This elevation of suture is in substance the greater portion of the third ligature, which quickly becomes softened and does not remain as a foreign irritant. The slight lateral bulging of the primary ligatures may touch one another, interfering with perfect coaptation, but this is completely obviated by inserting the suture loops 1.5 mm. behind or back from the end of the muscle. This suture method has been made feasible by the use of catgut for operations on the muscles.

A number of years of exclusive use has made me an enthusiastic advocate of catgut. It has many engaging attributes. I am confident that it is much less irritative and reactive than silk. With silk the reaction is increased the longer the suture is retained. With catgut the reaction subsides near the end of its retention. Catgut, by reason of slowly increasing caliber, cuts less and holds without trauma. Lester noted the comparatively nonirritative qualities fifty years ago.

Hermann Knapp,[10] than whom there was no keener observer, noted the strangulative quality of silk. He stated "The wound after the sixth day commonly begins to swell, for the tightness of the sutures may set up inflammation."

Accumulative swelling of tissue does not take place with catgut suture. It has a certain give and elasticity which obviate strangulation. Modern sterilization (both chemical and thermal) makes it absolutely safe, and this is doubly secured by its permeability to disinfectant agents. There is no danger of stitch abscess and no digging for sutures, as they do not require removal. This is a source of great satisfaction

10. Knapp, Hermann, in Norris and Oliver: A Textbook of Ophthalmology, Philadelphia, Lea Bros. & Co., 1893, vol. 3, p. 872.

and comfort to both the patient and the operator. That the suture holds is evidenced by the slightly elevated knots which will be found on the fifth day to be true to position. Another material advantage is that, by reason of its slightly swelling caliber, catgut obviates the necessity of large needles and heavy suture material, which every operator will admit is a source of trauma, thus permitting greater finesse and delicacy of operation.

000 catgut has a textile strength of about 3 pounds (1.3 Kg.), a plentiful strength reserve for any operation. The use of ligatured suture in cases of tension, with catgut as the suture material, I feel sure makes for security and stability.

SECURITY BY ADHERENCE TO CAREFUL DISSECTION OF MUSCLES

Skilful and careful dissection makes for security and stabilization of result. This applies not only to the smoothness of what should be done but also to the careful avoidance of what should not be done.

Unnecessary mutilations will not only weaken the corrective result but produce undue reaction, trying to the patient and sometimes a source of anxiety to the operator.

No surgeon can prescribe for another in detail how he shall do his work. There are some principles, however, which are of general importance, four of which I should like to emphasize.

1. Steps in the primary isolation of the muscle. It would almost seem unnecessary to mention as elementary a precaution as buttonholing the capsule to enable the strabismus hook to pass under the muscle, if one had not infrequently witnessed (without any attempt at primary incision or preparation) a fold of capsule forcibly dragged by the point of the strabismus hook under the muscle and ruthlessly ruptured, torn and traumatized. A primary and secondary buttonhole with some careful preparing of the way by scissors separation of the trabeculae makes for operative smoothness.

2. The value of cleancut delineating capsular incisions. If it were possible (and in some instances it is), an ideal method of advancement or recession would be to undermine the muscle and capsule, and without horizontal or oblique incisions, slide the capsule and muscle forward or backward. Adjustment of tissue does not render this feasible, but cleancut oblique or diverging incisions, extending from the upper and lower boundary of the muscle at its insertion and carried backward toward if not behind the equator, play an important part in such adjustment. The lines of divergence carried well away from the muscle boundaries serve to delineate the muscle and capsular flap discussed under the following heading:

3. The principles of flap retroplantations or anteroplantations. If the object to be attained is to strengthen a weak muscle by advancement and to leave a recessed muscle strong for the protection of convergence, unnecessary injury should be guarded against. The leaving of a muscle in continuity with its natural surroundings for a considerable area is accomplished by the principle of flap plantation. The muscle is left in its natural invagination. It is not sliced at its borders; it is neither stripped of its fibrous covering (the superficial and deep muscular layer of the capsule) nor wounded in any portion of its continuity, and its circulation and enervation are preserved to the greatest extent. By extending the incisions, the flap can be made large or small according to the requirements of the advancement or recession.

4. The avoiding of extended mutilations and unnecessary pocket dissection. A consideration which has led surgeons to extended posterior dissections when isolating the muscle is the prevalent opinion that the muscle must slip back or forward to a new position in the orbital tissue relationship. In a previous publication [9] I pointed out that no preparation of this nature, beyond certain limits, was necessary, and I demonstrated that after correction was attained, the muscle was left at or about the same plane in relation to the orbital content.

In the instance of recession the end of the muscle, being sclerally fixed to the globe, is pulled forward as the eye swings out to correction and regains its relation to the orbital content. Thus with recession it is never necessary to dissect or separate the muscle on its upper surface under the caruncle. This dissection should never extend further back than the semilunar fold. Posterior dissection should be confined to separation of the under surface of the muscle from the globe.

With advancement likewise, the muscle, being sclerally fixed to the globe, pulls itself backward as the eye swings to correction and regains its previous relation to the orbital content, and posterior dissection on the upper surface of the muscle need not extend further back than the point to which the operator intends to introduce his muscle sutures. Further dissection of the muscle is unnecessary.

Perfect adjustment of puckering or ruffling of the capsule is accomplished at the lips of the diverging incisions. With recession the lip of the incision nearest or adjacent to the muscle becomes shortened, and that furthest from the muscle elongated.

With advancement the reverse is the case. The lip nearest the muscle becomes lengthened and that furthest away is shortened. These adjustments take place as the eyes swing forward or backward to correction.

In these ways unnecessary dissection of the muscle and unnecessary mutilation can be avoided, and this makes for security and stabilization.

SECURITY BY CAPSULAR ADJUSTMENT

Parinaud,[11] in 1890, and Fox,[12] in 1900, both described capsular operations. In recent years surgeons have though so much in terms of muscles that capsular adjustments have not possibly received their due. They can be made a valuable aid to corrective returns in conjunction with muscle adjustment.

With advancement the capsule may be brought forward to increase the effect. The ligatured suture may be employed to advantage here. The ligation of capsule being made at a point posterior to the end of the muscle, near the posterior extremity of lateral incisions, the sutures are then brought forward and tied to the insertion of the muscle. In high tension resections the capsule can be made to remove the tension on the end of the muscle during the healing period by picking up a bite above and below well back of the plane where muscle sutures are introduced, ligating them and advancing them to the insertion. The Reese operation picked up the capsule, and this greatly enhanced its value.

Many of the extreme resections in which a large portion of the muscle fiber has been removed must necessarily rely on the capsular and fibrous element to sustain the correction.

Capsular adjustments are equally feasible on the side to be recessed. Excessive muscular tension is usually accompanied by capsular tension, and if, in the case of an internal deviation after the muscle has been tenotomized, forcible rotation outward points to capsular tension on the inside, a vertical capsulotomy extending to the borders of the superior and inferior recti may be performed. This can be done with comparative impunity if scleral fixation and gradation are practiced.

Capsular adjustments, with either advancement or recession, play an important part in stabilizing operations on the muscles.

AFTER-TREATMENT WHICH COMBATS REACTION

The observation that the detachment of a muscle from the globe and the free opening of a capsule were followed by an unusually free outpouring of serosanguineous discharge led me to give more attention to after-treatment.

If the eye was not dressed for twenty-four hours, the accumulated secretion was a source of irritation and converted the dressing into a moist pad which poulticed the eye and encouraged bacterial growth. The adoption of a tridaily change of dressing, accompanied at the same time by mild surface irrigation, a drop or two of a bactericidal solution

11. Parinaud, H.: Opération du strabisme sans ténotome, Compt. rend. Acad. d. sc. **110**:805, 1890.

12. Fox, L. W.: A Simple Operation for Strabismus, Tr. Sect. Ophth., A. M. A., 1900, p. 68.

and brief application of ice compresses greatly reduced the reaction, kept the eye perfectly clean and not only added to the comfort of the patient but enhanced the healing process.

CONCLUSIONS

In these pages I have endeavored to outline the following agencies which are not commonly emphasized:

Recognition of, and diligent efforts to obtain an intimate understanding of, the causes of squint.

Careful computation and gradation based not on deviation alone but on all the underlying factors.

The consideration of reduction in muscular strength by true relaxation, and also by the induction of hypertension, and the utilization of these factors to the best advantage.

The selection of the operative procedure best adapted to the existing conditions, with careful weighing and evaluation of effects.

The giving of the same requisites of scleral fixation and gradation to tenotomy as to advancement.

The appropriate use of the principles of ligated sutures, careful unmutilated dissection of muscles and supplementary capsular adjustment for both advancement and recession.

The postoperative care which combats inflammatory reaction.

The practice of these principles will, I believe, add much to security and stabilization in operations on the ocular muscles.

ABSTRACT OF DISCUSSION

Dr. James W. White, New York: Dr. Jameson's paper points out many of the pitfalls of operations on the muscles, and his advice as to how to avoid these by proper diagnosis and by definite operative procedure is sound. Since the causes of strabismus vary so, and since the true type is at times so difficult accurately to determine, I have made it a rule in doubtful cases to explore all muscles in question, and to decide on the procedure only after determining the exact character of these muscles.

The condition of hyperactivity is very important. A child, 22 months old, was referred to the muscle clinic with a diagnosis of congenital paralysis of both externi. Neither eye could be abducted beyond the midline. However, on repeated tests one got the impression that the externi would abduct if they were given a chance. Both interni were exposed and found to be powerfully hyperactive muscles. A generous recession was done on each muscle, and since recovery the abduction is normal in each eye.

Another point to be stressed is the importance of correcting vertical deviations before attacking the lateral. There are exceptions to this rule, but the more experience one has with this procedure the fewer exceptions are seen.

An extremely important consideration is the convergence near point. Many cases of marked strabismus have a remote near point, and one that may be normal on testing is poorly held, especially when the patient is relaxed as in reading. In

these cases the interni would rarely be attacked, but the entire result obtained by increasing the action of the externi.

Dr. Eugene M. Blake, New Haven, Conn.: Dr. Frank Carroll and I have studied the process of repair following the various operations performed on the extra-ocular muscles, and have made histologic observations at different stages of the healing process. The operations were performed on rabbits' eyes, and the eyeballs and muscles were removed at various intervals from two to forty days following the operation.

In some instances there was fairly firm union after simple tenotomy within a few days, while in other cases, even after a much longer period of time, the attachments were feeble and broke away when moderate traction was applied. In two cases no reattachment of the tendon took place. On the contrary, when the Jameson operation of recession was done, there was firm attachment in every instance, and the tendon applied itself to the point where sutures were placed. In the eyes on which a recession operation had been performed, the end of the muscle (the tendon being very short in the rabbit) was attached to the sclera by a fairly compact network, consisting chiefly of fibroblasts and capillaries.

Dr. F. H. Verhoeff, Boston: In almost all cases of convergent strabismus there is not, never was and never will be any power of binocular fixation. The thing that influences me most in deciding whether to perform a tenotomy for strabismus is whether or not the eye is prominent. Of course, there is another question, and that is whether there is overaction of the muscle, or excess of the opposing muscle. That is important, but I think that it is more important to get a good cosmetic effect. If the eye is prominent, I think a tenotomy is not indicated because it makes the eye more prominent.

In regard to the technic of the operation, I do not think that all this careful work is necessary. I have performed a great many tenotomies without taking any special pains, except not to cut the muscle very close to the insertion, and the results have been very good. I always carry out Dr. Theobald's idea of separating the conjunctiva back to the caruncle. Of course one should not overdo the freeing of the tendon.

Dr. P. Chalmers Jameson: I am indebted to Dr. White for the points brought out by his illustrative cases. In my early work on recession, I frequently noted that an externus exhibiting its weakness by faltering in abduction, say 5 mm. from the outer canthus, would freely abduct and function to the canthus after the requisite recession on a hypertensive internus had been performed.

Dr. Blake's painstaking work is valuable and interesting. I can clinically corroborate much that he has brought out. I hope that he will carry his research further, and elucidate some of the points still under dispute.

My paper is, to a certain extent, in accord with Dr. Verhoeff's evaluation of the old tenotomy, with this reservation that tenotomy, as practiced blindly in past days, has been universally deprecated by ocular surgeons, and I believe properly so. On account of its erratic return of correction, its secondary deviation and caruncular retraction, it has been relegated by most surgeons to the position of a secondary procedure to augment the correction obtainable by advancement. I cannot, however, feel that he has advanced any good argument which would lead one to cling to the old unrestrained and somewhat irresponsible tenotomy, because I believe that there is something much better. Even to the ophthalmologist who has not yet practiced its principles, recession must have an academic appeal in that, among other attributes, it substitutes accuracy and safety for inaccuracy and doubtful safety. As to that portion of my paper which advocates the endeavor

to diagnose and render more accurate the selection of operation, I do not think that there can be too much emphasis on the value of coming to a closer understanding on this question. In comparing an active experience of many years in the practice of the old tenotomy with this entity, I feel confident that many of the generally disappointing postoperative returns of correction have been attributable to two causes: first, to the blind unbridled tenotomy of a hypertensive muscle, irrespective of the precaution of obtaining definite scleral fixation at or in front of the equator, and, second, to the tenotomy of a muscle without due consideration of the anatomic, enervational and tensive conditions underlying the deviation to which I have already referred. These conditions are definitely recognized in the entity of recession, and may contraindicate tenotomy and point to the primary emphasis of an advancement on the opposing side. The faculty of binocular fixation should not be confused with that of synchronous convergence, which is, as a rule, preserved in strabismic eyes and, as mentioned, is one of the most valuable tests in determining the procedure. The entity of recession, by reason of the attributes of definite scleral fixation, accurate gradation and painstaking computation, has placed tenotomy on the same plane of accuracy and security as advancement, and it is illogical not to apply these requisites to both.

THE USE OF TUBERCULIN IN DIAGNOSIS AND TREATMENT IN OPHTHALMOLOGY

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The use of tuberculin as a diagnostic measure is becoming more universal as newer and more reliable methods of application have been developed. While this is true of its use in detecting the tuberculous status of patients, its use as a measure of treatment has practically suffered the fate of therapeutic nihilism by specialists in tuberculosis. As tuberculin, both diagnostically and therapeutically, has survived chiefly in the specialty of ophthalmology, it appears timely to present before this section any experience that would support or discredit such a controversial subject.

The breadth of the field which should be covered in order to present the subject at hand in anything like completeness permits only a brief and sketchy presentation without citing the details of the data and experiments by which the present conception and conclusion of the effect of tuberculin have been obtained.

The correlated experiments and opinions of the most profound students of tuberculosis, such as Koch,[1] Pirquet,[2] Krause,[3] Baldwin,[4] Calmette,[5] Petroff,[6] Pottenger,[7] Zinsser [8] and many others prove that two distinct tissue responses occur following the development of an organized tubercle in the body. These consist of the development of a bacterial immunity in which the usual antibodies can be demonstrated, and, in addition, hypersensitiveness and allergy, demonstrable by the reaction of the skin or mucous membrane to the by-products of the growth of

Read at a meeting of the Section of Ophthalmology, New York Academy of Medicine, March 21, 1932.

1. Koch: Deutsche med. Wchnschr. **17**:1189, 1891.
2. Pirquet: Berl. klin. Wchnschr. **44**:644 and 699, 1907.
3. Krause, A. K.: Am. Rev. Tuberc. **1**:65, 1917; **18**:208, 1928.
4. Baldwin: J. M. Research **22**:189, 1910.
5. Calmette, A.: La vaccination préventive contre la tuberculose par le B. C. G., Paris, Masson & Cie, 1927.
6. Petroff, S. A., and Stewart, F. W.: J. Immunol. **12**:97, 1926.
7. Pottenger, F. M.: Am. Rev. Tuberc. **18**:570, 1928; Ann. Int. Med. **1**:283, 1927.
8. Zinsser, H., and Parker, J. T.: J. Exper. Med. **37**:275, 1923. Zinsser, H., and Petroff, S. A.: J. Immunol. **9**:85, 1924. Zinsser: Resistance to Infectious Diseases, New York, The Macmillan Company, 1931.

the tubercle organisms. These by-products are chemically complicated substances consisting of nucleoproteins, carbohydrates and fats, and are designated as tuberculin. Some believe there is a close interdependence of the phenomenon of allergy and that of immunity against the invasion of tubercle bacilli and that both reactions take place in the resistance to the infection, while others think the two reactions are independent of each other. Nevertheless, the allergic phase of the tissue represents an increased irritability of the cellular mechanism to the specific antigen, and, as a consequence, a renewed contact with tuberculin arouses a quick trigger-like response which favors the elimination of the infection.

It is therefore held rather dogmatically that a positive reaction to tuberculin signifies an infection with tuberculosis, either actively progressing or of a healed or latent nature. As most people, after their second year, have had a tubercle in some location in the body, from 40 to 75 per cent give a positive tuberculin reaction of some degree. The assumption of active infection of this mass of people by tuberculosis may be somewhat erroneous, because the reaction has been produced by the ingestion of avirulent tubercle bacilli and also by the injection subcutaneously of dead tubercle bacilli. Likewise, it has not been proved that the introduction of tubercle bacilli in food and drink will not sensitize.

The tuberculin test may be performed according to several technics. The most popular are Pirquet, Mantoux or intradermal, and subcutaneous tests. Of these, the intradermal test has become the more extensively used on account of its sensitiveness and safety. As the procedure is generally known, only certain important features will be discussed.

Freshly diluted Koch's old tuberculin is used in the test in dilutions of 1 : 100,000, 1 : 10,000 and 1 : 1,000, 0.1 cc. of each dilution being injected intradermally. These represent tuberculin in milligrams, as follows: 0.001, 0.01 and 0.1 mg. If the foregoing amounts fail to give a positive reaction and the clinical symptoms suggest a more critical test, 1 mg. may be used. It is necessary that a reliable, fresh preparation be used in the tests and that the solution be injected directly into the epidermis. A correct technic is revealed by a hard white wheal in the skin. If tuberculin is injected beneath the epidermis, it is quickly dispersed in the tissues, resulting in a negative test, and no local reaction will occur. The test had best be read at intervals of forty-eight hours and reported in terms of plus or measurements of the degree of redness and induration. In a few cases the two dilutions are given at first in order to avoid severe reactions, but usually this is not necessary and the three dilutions are given. All tests are controlled by giving an injection of saline diluent. Briefly, the significance of the test is as follows:

1. A negative test indicates:

(*a*) The patient has had no contact or tissue reaction either to dead or to viable tubercle bacilli.

(*b*) As it takes from four to eight weeks for the test to become positive, it is possible that the test may have been made in the incubation period, just as a negative Wassermann reaction may be obtained during the chancre period of syphilis.

(*c*) The patient's body may be so overwhelmed by the infection that no sensitization or immunity to the tuberculin has developed. This occurs frequently in children in general miliary tuberculosis.

(*d*) The test may have been rendered negative by a severe illness, accompanied by a high temperature, as after influenza, measles, pneumonia, etc.

(*e*) The test becomes negative after the therapeutic desensitization injections of tuberculin.

(*f*) The tuberculin injected may be inert, or has been improperly injected.

2. A positive test indicates that the patient has had or is having tuberculous tissue reactions, to either dead or viable bacilli, however,

TABLE 1.—*Intracutaneous Tuberculin Tests for Six Years, 1926-1931, Inclusive*

Year	Positive	Negative	Total
1926	98	129	227
1927	115	140	255
1928	125	160	285
1929	155	175	330
1930	164	182	346
1931	210	275	485
Total for six years	867 44.9%	1,061 55.1%	1,928

small or in whatever location of the body, but not necessarily in the organ producing the symptoms of which the patient complains. In other words, a patient with ophthalmic symptoms reacting to tuberculin does not by any means prove that the pathologic process in the eye is actively a tuberculous lesion. As many patients complaining of ocular symptoms react to tuberculin, which is also true of patients in normal health, some ophthalmologists erroneously conclude that the ocular lesion is tuberculous; and tuberculin is unfortunately used by some to indicate their diagnostic acumen, when the law of average is greatly in their favor that the patient will in any event react to it. A positive tuberculin test is poor evidence that these patients have tuberculosis of the eye.

Table 1 presents the results of the tuberculin tests at the Manhattan Eye, Ear and Throat Hospital in the last six years.

An understanding of the significance of a positive reaction is quite essential to those who employ the test, because this reaction illicits anxiety in patients, and one is usually bombarded with pertinent questions as to the importance of the test. It is a question of great concern to the layman to have a positive test, and the physician is frequently

confronted with the task of allaying the fear of the patient and therefore should know its significance.

In the light of the most recent investigations, tuberculous lesions may occur in several forms. When the bacterial bodies are actively present, a well organized tubercle occurs as a tissue response to the infection, and this is the true tuberculous process. On the other hand, many conditions, undoubtedly of a tuberculous nature, occur in response to the toxin of tuberculosis and are considered of an allergic nature, namely, serous pleurisy, skin tuberculids and various ocular lesions in which no tubercle or bacilli can be demonstrated. These lesions are not true tuberculosis, but are allergic phases of the disease. It is important that ophthalmologists recognize the distinction of the two processes. This distinction will have an important weight in deciding for or against the use of tuberculin as a therapeutic agent. This distinction has not been sufficiently appreciated in the past and undoubtedly explains the variable reports of the value of tuberculin in the treatment of ocular lesions.

TABLE 2.—*Extent of Tuberculin Treatment in Three Years*

	1929	1930	1931	
Histories on file December 31	114	237	198	
Treatments administered	4,672	6,748	7,140	
Total treatments				18,560
Average number of treatments per month	389	563	595	
Average number of treatments per day	46	66	71	

Tuberculin is unlikely to produce favorable results in the tuberculous infected lesion and may produce injury, while it is the drug indicated and acts specifically in the allergic cases.

Tuberculin as a therapeutic agent has, in the past, had its ardent advocates in practically every specialty of medicine. It has also had its equally ardent critics. The critical attitude toward the use of tuberculin seems to be in the majority at present, and its use has been practically discontinued with the exception of its use in ophthalmology. For this there seems no adequate explanation, unless it has given a measure of results and has survived in spite of all criticism. This may be a pivot around which opinion may swing and in time revive the use of tuberculin in other phases of medicine.

Tuberculin has been employed therapeutically in the clinics of the Manhattan Eye, Ear and Throat Hospital for many years. A glimpse at the extent of its use is given in table 2.

Tuberculin is administered according to a schedule of doses and is given periodically and uninterruptedly. The doses are small at the beginning and are safely and gradually increased until a series of injections is completed. A thorough course of treatment requires from several months to a year. The schedule of doses is given in table 3.

The amount of tuberculin given in the schedule is perfectly safe for the average patient. An attempt to individualize the case is made when the patient has an intolerance to the injections. The schedule provides

TABLE 3.—*Schedule for Tuberculin Treatment at Manhattan Eye, Ear and Throat Hospital* *

Bacillin Emulsion					
Dilution 1:10,000			Dilution 1:100		
	Minims	Mg.		Minims	Mg.
1st dose	3	0.0001	37th dose	3	0.01
2d dose	6	0.0002	38th dose	6	0.02
3d dose	9	0.0003	39th dose	9	0.03
4th dose	12	0.0004	40th dose	12	0.04
5th dose	15	0.0005	41st dose	15	0.05
6th dose	18	0.0006	42d dose	18	0.06
7th dose	21	0.0007	43d dose	21	0.07
8th dose	24	0.0008	44th dose	24	0.08
9th dose	27	0.0009	45th dose	27	0.09
Dilution 1:1,000			Dilution 1:10		
	Minims	Mg.		Minims	Mg.
10th dose	3	0.001	46th dose	3	0.1
11th dose	6	0.002	47th dose	6	0.2
12th dose	9	0.003	48th dose	9	0.3
13th dose	12	0.004	49th dose	12	0.4
14th dose	15	0.005	50th dose	15	0.5
15th dose	18	0.006	51st dose	18	0.6
16th dose	21	0.007	52d dose	21	0.7
17th dose	24	0.008	53d dose	24	0.8
18th dose	27	0.009	54th dose	27	0.9
Dilution 1:100			Dilution 1:100		
	Minims	Mg.		Minims	Mg.
19th dose	3	0.01	55th dose	3	0.01
20th dose	6	0.02	56th dose	6	0.02
21st dose	9	0.03	57th dose	9	0.03
22d dose	12	0.04	58th dose	12	0.04
23d dose	15	0.05	59th dose	15	0.05
24th dose	18	0.06	60th dose	18	0.06
25th dose	21	0.07	61st dose	21	0.07
26th dose	24	0.08	62d dose	24	0.08
27th dose	27	0.09	63d dose	27	0.09
Dilution 1:1,000			Dilution 1:10		
	Minims	Mg.		Minims	Mg.
28th dose	3	0.001	64th dose	3	0.1
29th dose	6	0.002	65th dose	6	0.2
30th dose	9	0.003	66th dose	9	0.3
31st dose	12	0.004	67th dose	12	0.4
32d dose	15	0.005	68th dose	15	0.5
33d dose	18	0.006	69th dose	18	0.6
34th dose	21	0.007	70th dose	21	0.7
35th dose	24	0.008	71st dose	24	0.8
36th dose	27	0.009	72d dose	27	0.9
			Continue dilution 1:10 dose 1 cc. for one year		

* Injections to be given at intervals of three to four days. The foregoing is the advised schedule; however, if any severe reaction should develop, the physician will have to individualize a dosage for that particular case by decreasing dose or lengthening the interval between injections.

a period of rest, while at the same time the effect of the tuberculin is not altogether lost. This is accomplished by increasing the strength of the dilution of 1 : 10,000, 1 : 1,000 and 1 : 100, and returning to the dilution of 1 : 1,000 and 1 : 100, and then proceeding to 1 : 10. After a

series of this dilution is finished there is a return to the 1 : 100 dilution, and the patient is again carried forward to the larger and stronger doses. This schedule has been in use for years, and no known bad results or general reactions to the tuberculin have been noted. The patients are carefully studied and followed through the social service department of the hospital. A few patients with rather severe local reactions have required a decrease in the dose or an increase in the interval between doses; the reactions in but few of the patients have been of such a severe nature as to make it necessary to discontinue the injections altogether.

Before giving injections of tuberculin to persons with strongly positive reactions, every effort should be made to determine the degree of activity of the tuberculous condition. A careful history, physical, laboratory and roentgenologic status should be obtained, and, if actual tubercle lesions are found, the use of injections of tuberculin is questionable and should be undertaken with the greatest precautions. The

TABLE 4.—*Statistics on Cases Reported in the Literature*

Authors	Number of Cases	Healed, per Cent	Improved, per Cent	Unimproved, per Cent
von Hippel	213	75.7	17.3	7.0
Weigelin	77	41.6	34.0	24.4
Hartig	38	26.3	42.0	31.7
Fleisher	43	51.0	35.0	4.5
Woods and Rones	42	45.0	45.0	10.0
Török	85	67.0	17.5	15.5

Hertel: 21 per cent more patients healed with specific than nonspecific methods

patient should procure, in addition, all the general supportive measures of treatment used in general tuberculosis. On the other hand, if no active tubercles are found and the case is one in which an allergic phase predominates, it is admirably adaptable for the use of tuberculin as a desensitizing antigen.

A historic review of the opinions of various ophthalmologists on the value of tuberculin reveals the controversial views as to its value. The majority seem to credit tuberculin as an essential and valuable adjunct to the treatment of many ocular lesions. King [9] recently published a table on the subject which is worthy of review in this discussion.

The authors quoted by King support the efficiency of tuberculin. On the other hand, many authors have failed to obtain favorable results. More recently, Derby and Carvill,[10] in the study of a series of cases, conclude that treatment with tuberculin has no specific or lasting effect.

Many of the statistics available at present on the therapeutic value of tuberculin do not differentiate the types of tuberculous lesions of the

9. King, Clarence: The Therapeutic Value of Tuberculin in Ophthalmology, Arch. Ophth. **1**:713 (June) 1929.

10. Derby, G. S., and Carvill, M.: Tr. Am. Ophth. Soc. **25**:523, 1927.

eye. It is therefore impossible to determine if the authors were treating tuberculous infectious lesions, or those of an allergic nature.

The mechanism of the probable effect of tuberculin has received experimental support along the following lines. It is known that injections of tuberculin produce some active immunity against the bacteria by the tissues and fluids of the body, and in this way it has a specific immunologic effect, which is perhaps a minor rôle as employed in ophthalmology as few of the ocular lesions contain active tubercle bacilli, and granting that they did, little specific immunity has resulted from injections of tuberculin in known tuberculous processes.

If the lesions are in the nature of an allergy, tuberculin is the logical treatment in desensitization, by gradual and increasing doses of the reagent. This is probably one of the major actions of the injections.

As tuberculin is of a protein nature, its use will produce nonspecific therapeutic reactions. These reactions may, to a certain extent, be duplicated by other proteins, such as horse serum, milk, erysipelas and prodigiosus toxins (Coley's) or other bacterial products, all of which stimulate the production of blood ferments and cellular metabolic processes. This stimulation is more effectively produced if the body tissues show a certain sensitivity to tuberculin. It therefore becomes the logical foreign protein to be used in the patients who show a positive tuberculin reaction.

CONCLUSION

The ocular lesions frequently diagnosed as tuberculosis in a patient with positive reactions to tuberculin are really not due to infection by tuberculous bacteria, with the formation of a tubercle, but are of an allergic nature, if they are in any way related to tuberculosis. Actual tuberculous infection of the eye is relatively rare.

Injections of tuberculin are of value in the allergic cases if given properly in order to desensitize the patient, but of questionable value in the active tuberculous ones.

Tuberculin is the foreign protein of choice if the cellular metabolic mechanism of the tissue is to be excited, as a greater response occurs to a protein if there is cellular sensitization.

ABSTRACT OF DISCUSSION

DR. ARNOLD KNAPP: Dr. Eggston's communication is valuable, because he speaks as a trained bacteriologist. I am a strong believer in the value of tuberculin in certain types of ocular conditions. The subject is so large that we could spend the rest of the evening answering certain questions that naturally come up. I am going to limit my discussion to two points. Dr. Eggston makes a point of distinguishing between two types of tuberculous infection of the eye, one in which many bacilli are present and the other which is a toxic action. I should like to have him explain how one is clinically to recognize these two different types. Is it not more

likely that every focus has both bacteria and toxins, and that the inflammatory reaction which develops on the part of the tissue is an indication of the state of the immunity of the patient affected?

My second question is, given a patient with definite tuberculous symptoms clinically, but negative to tuberculin tests, would that patient be benefited with tuberculin?

DR. BERNARD SAMUELS: My part of the discussion consists in showing a few slides to refresh our memories as to some of the anatomic points in tuberculosis of the eye. These preparations all show the typical structure of tuberculosis. We have other preparations that do not show the typical structure but that we believe to be of tuberculous origin, and they may belong to the type that Dr. Eggston refers to as allergic.

Of the various sites of tuberculosis of the uveal tract, it is likely that the most favorable one for spontaneous cure and for healing under treatment is in the posterior segment where the layer is more firmly fixed to the sclera and immobile. Anteriorly the ciliary body and iris are in almost constant motion.

Cases of conglomerate tuberculosis of the choroid may closely simulate sarcoma. It is interesting that an enormous tuberculous process with caseation can exist in the posterior part of the eye, and yet cause little or no inflammatory signs anteriorly. Such a process is apt to be accompanied by detachment of the retina, which obscures the tuberculous growth, rendering the diagnosis all the more difficult. Whether or not a mistake is made in removing such an eye makes little difference, because the process goes on sooner or later to perforation. In either case enucleation is indicated. A tuberculous mass of any great size at any point in the uvea, even if it has healed, would lead to an atrophic globe.

Tuberculosis in the posterior half of the globe is not so frequent as that in the anterior structures, the iris being said to be the most frequent seat. This structure may be entirely replaced by tuberculous degeneration, and yet the cornea reveal almost no change. A tuberculous process merely replaces tissues, causing them to disappear by pressure atrophy. No structure of the eye can withstand this malignant trait of tuberculosis. Thus tuberculosis at the root of the iris may erode the cornea and sclera appearing on the surface, clinically resembling a staphyloma. In touch with the lens it causes pressure atrophy in the same manner as a sarcoma does.

As an example of the tendency of tuberculosis to confine itself to zones, a case of infiltrating tuberculosis taking in the entire ciliary body is shown, and yet the iris is so little affected that there is a complete absence of posterior synechia. The eye was soft no doubt, and on account of hypotonia the nerve head is edematous and a circumpupillary cystic degeneration has developed.

In a microscopic examination of a number of eyes that have been treated with tuberculin, there appear to be no anatomic changes in the tissues that would lead one to surmise that the treatment had produced any effect. It would seem that any eye having a large tuberculous focus is without hope, with or without treatment.

My opinion is that most eyes clinically diagnosed as suffering from tuberculosis would be found to have typical foci of giant cells, epithelioid cells and lymphocytes with caseation, actually indicating the presence of the bacilli. This is all the more likely in cases showing large mutton fat deposits on the cornea, which represent particles that have broken off from tuberculous nodules on the surface of the iris or ciliary body. Eyes suffering from the toxins of tuberculous centers elsewhere in the body would be likely to show only a lymphocytic infiltration with ordinary deposits on Descemet's membrane.

It is not to be overlooked that eyes that are not suffering from tuberculosis are often treated with tuberculin under a wrong diagnosis. That these cases do not respond may shake one's faith. One of the most convincing proofs of the efficacy of tuberculin was given to me by Dr. Clyde E. McDannald, who described a case of multiple tubercles of the iris which disappeared only after injections of tuberculin were instituted. My belief is that tuberculin is of great benefit in all forms of ocular tuberculosis, particularly in tuberculosis of the cornea. What is misleading is that one dwells too often on the eyes that have been lost—lost because patients come too late for treatment or for other reasons—and not enough on the eyes that have been saved.

Dr. Ernest F. Krug: I shall confine my remarks to a report on the effect of tuberculin on myself.

In 1928 a deep keratitis developed in my left eye and I spent a month at the hospital under Dr. Knapp's vigilant care and treatment. I then left for Banff and recovered without the use of tuberculin.

One year later my right eye became affected with a more severe process, a cyclitis with deep keratitis, and it was thought advisable to try tuberculin. I began my treatment with 1:10,000 mg. of old tuberculin as prepared by Mulford, and I went back to Banff. My experience with the tuberculin was negative until I had reached a dosage of 1:100 mg.; then I experienced a real reaction with a slight rise in temperature, a general feeling of depression and discomfort and a distinct reaction in my eye. This manifested itself through a dread of light and a definite increase in the tenderness of the eyeball. Up to that time my vision had not improved. I felt I was not getting any worse, but I knew I was not getting any better. The reaction in the eye frightened me somewhat as I had always been fearful of such a reaction in the use of tuberculin on my patients. I had used it for years and can report many striking cases of cure, but it was the first time I had used it on myself.

When the reaction wore off after forty-eight hours, I was surprised to find that my eye felt much better and that I could see better. I repeated the injection, not increasing the dosage, getting a similar reaction but not so severe, and after the reaction again wore off, repeated the same dosage until again I seemed to get no effect from the tuberculin. I then increased the dosage slightly until I had reached 1:10 mg., when I again experienced the same reaction, a more severe one in the eye, and I came to New York.

Dr. Knapp advised me to decrease the dose of tuberculin, and I began again with 1:1,000 mg., gradually increasing it. Whenever I had a reaction in my eye such as I have described I would reduce the dose and in this way I gradually worked it up to 1 mg. and there I stopped. The treatment covered a period of seven months.

This personal observation leads me to believe that if there is a true tuberculous process in the eye one must get a reaction in the eye at some time from the use of the tuberculin, and when a reaction does occur, one definitely knows that a tuberculous process is being dealt with.

I was not convinced in my own case until I had had this reaction that my trouble was a tuberculous cyclitis. Furthermore, the reaction actually benefited my eye, so that I do not think one need fear the reaction unless the tuberculin is pushed too much. One should rather welcome evidence of the effect on the eye by the tuberculin and should not be afraid of it but be careful in increasing the dosage.

As stated before, I went to Banff and the change was unquestionably beneficial, but I also feel that in my case tuberculin contributed to my recovery. I find that my right eye, which was much the worse of the two eyes, has completely recovered

with 20/20 vision and I am perfectly comfortable in this eye. The vision in my left eye which recovered without the tuberculin is not quite so good as that of the right eye.

DR. DAVID WEBSTER: A few days ago Dr. Eggston asked me if I would discuss his paper on experiences with tuberculin from the side of the clinical findings on the hospital records at the Manhattan Eye, Ear and Throat Hospital.

Time permitted me to examine the records, taken at random, of one hundred patients who had been treated. Of these patients, forty-one could not, on such short notice, be called by the social service department to the clinic for a final examination.

The treatments were given for twenty-three different conditions:

Ulcerative keratitis, 13; interstitial keratitis, 12; keratitis not specified, 12; phlyctenular keratitis, 9; marginal keratitis, 5; sclerosing keratitis, 2; keratitis neuroparalytic, 1; dendritic keratitis, 1; totaling 54 per cent of the cases.

Uveitis, 9; choroiditis, 5; chorioretinitis, 2; iritis, 3; kerato-iritis, 5; totaling 24 per cent.

Phlyctenular conjunctivitis, 3; conjunctivitis not designated, 7; episcleritis, 3; iritis and scleritis, 1; exudative retinitis, 3; vernal catarrh, 1, and neuroretinitis, 1.

The intensity of the reaction for the strongest solution showed four plus, 52 per cent; three plus, 22 per cent; two plus, 11 per cent; one plus, 2 per cent; positive, but degree not given, 5; negative, 3; no test given, 5. Two cases of kerato-iritis, one of chorioretinitis and one of interstitial keratitis also showed four plus Wassermann reactions.

The results of treatment in the cases studied was as follows:

Of thirteen patients with ulcerative keratitis, whose average age was 20 and who received an average of 63 treatments, five were cured, one showed improvement of vision and two decrease of vision; one of the latter received 243 injections over a period of several years, with intermissions, showing marked reaction at times, had additional systemic treatment and was sent to the country. Five had no final examination. Of nine patients with phlyctenular keratitis, whose average age was 11 and who received an average of 55 treatments, six showed good results with the eyes clear, three improvement of vision, and three had no final examination.

Of twelve patients with interstitial keratitis, whose average age was 14 and who received an average of 83 treatments, two showed improvement of vision, one decreased vision, two good final vision, and five had no final examination.

Of twelve patients with marked keratitis (not specified), whose average age was 23 and who received an average of 72 treatments, six showed improvement, and six had no final examination.

Of five patients with marginal keratitis, whose average age was 26 and who received an average of 148 treatments, two were cured, one had marked good vision, and two had no final examination.

Of two patients with sclerosing keratitis, one, aged 19, received 129 injections, but there was no final notation; the second, aged 28, received 85 injections, and vision improved from right 20/50 and left 20/40 to 20/30 in each eye, when treatment was stopped.

One patient with dendritic keratitis, aged 31, received 28 injections; vision was 20/20 in each eye, and the last note on the card said "patient telephoned eyes seemed normal."

One patient with neuroparalytica of both eyes, aged 22, received 103 injections, and vision was 20/100 in each eye. At the end of treatment, vision in the right eye was 20/100, and with the left eye fingers could be seen at 18 inches.

Of nine patients with uveitis, whose average age was 30 and who received an average of 38 treatments, six showed improvement, one from vision of 20/100 to 20/20 plus, one from perception of light to 20/50, and one, whose eye was quiet and tension normal, from 20/100 to perception of light. One had no final examination.

Of five patients with choroiditis, whose average age was 29 and who received an average of 36 treatments, two showed improvement, one decreased vision, and two had no final examination.

Of two patients with chorioretinitis, one, aged 39, who received 32 injections, had a four plus Wassermann reaction but showed no improvement; the other, aged 42, received 45 injections; vision in the right eye improved from perception of light to hand movements; in the left eye, from 20/100 to 20/40, with eyes quiet.

Of three patients with iritis, whose average age was 25 and who received an average of 94 treatments, two had vision of 20/20 with eyes quiet, and one had no final examination.

Of five patients with kerato-iritis, whose average age was 33 and who received an average of 52 treatments, two were cured, one showed no improvement, and two had no final examination.

Of ten patients with conjunctivitis, whose average age was 26 and who received an average of 43 treatments, three were cured, one improved, and six had no final examination.

Of three patients with episcleritis, whose average age was 34 and who received an average of 62 treatments, one was cured, and two had no final examination.

One patient with iritis with scleritis, aged 33, received 73 injections and stopped on account of severe reactions.

Of three patients with exudative retinitis, one, aged 30, received 19 injections but had no final examination; the second, aged 13, received 35 injections and was sent to the country, with vision improved from right 20/70 and left fingers at 2 feet to right 20/50 and left 20/40, lesion healed; the third, aged 56, received 55 treatments. He had an old central lesion and an acute lesion adjacent to it. The left eye was amblyopic, but treatment effected no improvement.

One patient with vernal catarrh received 45 treatments; no final examination was made.

One patient with neuroretinitis, aged 32, received 13 injections. Vision improved from 20/50 and 20/30 to 20/20 in each eye.

Of the fifty-nine patients with final notations, 30 were improved, 18 cured, 5 not improved and 5 worse.

I agree with Dr. Eggston that patients with active tuberculous lesions do not show improvement. I am convinced from both clinical and private experience that tuberculin is one of the best therapeutic agents.

DR. EGGSTON: This subject, of course, is not as simple as presented. If possible, the types of lesions should be separated clinically. Pathologically, it is difficult to make a distinction in a case because the eyes are not available for examination.

If there is a distinct tubercle formation, it is most likely an infectious lesion, and that is the type in which tuberculin should be used with great care. If the lesions are diffuse, exudative or hemorrhagic, they are probably of the allergic type. On the other hand, the allergic lesions in tuberculosis may be histologically similar to that actually due to viable tubercle bacilli. The allergic lesions are considered by many an immunity phenomenon and occur secondary to dead tubercle bacilli as well as to many of the toxic by-products. The differentiation is not always easy, but an attempt to classify the cases should be made, because there is considerable confusion at present, in the treatment of ocular lesions, as to whether they are

tuberculous cases or of a toxic nature. Generally, the more certain clinically that it is tuberculosis, the less suited it is for injections of tuberculin. If there is a question in the diagnosis, and the patient gives a positive reaction, the case is suited for injections.

If a case is clinically tuberculosis, but gives a negative tuberculin test, it would seem that tuberculin would have no advantage over any other foreign protein as a therapeutic agent.

BACTERIOPHAGE IN OPHTHALMOLOGY

A PRELIMINARY REPORT

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AND

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Recently notable advances have been made in bacteriology and immunology which are of utmost importance and have changed the older concepts in regard to the growth and destruction of bacteria. These discoveries have a practical application in medicine and surgery, and an attempt is being made to apply some of these new principles to ophthalmology with the hope of providing some additional methods of treatment of ocular infections.

In 1915, Twort [1] published a paper in which he made certain observations on a lytic agent. He noted that it acted only on living bacteria, was reproducible in series and would pass through the finest bacteriologic filter. He suggested several theories regarding its nature; that it might be a living ultramicroscopic organism, a tiny ameba or an enzyme with the power of growth.

In 1916, d'Herelle [2] made an interesting observation. He took a small amount of the stool from a patient convalescing from bacillary dysentery (Shiga) and placed it in a tube of bouillon, incubated it over night and filtered it through a Chamberland filter, obtaining a sterile filtrate. Into bouillon previously inoculated with Shiga bacilli about 10 drops of this filtrate were placed, and the material was incubated. In a few hours it was diffusely cloudy, but the next day the tube was clear and sterile. The process was repeated several times, with the addition each time of a drop of the culture previously dissolved to a fresh culture of Shiga bacilli. In this repetition of the process, he noticed that the activity, instead of becoming weaker, became more and more

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1. Twort, F. W.: An Investigation on the Nature of Ultra-Microscopic Viruses, Lancet **2**:1241 (Dec. 4) 1915.

2. d'Herelle, F.: The Bacteriophage and Its Behavior, translated by George H. Smith, Baltimore, Williams & Wilkins Company, 1926.

pronounced. He deduced that the principle present in the intestinal contents was regenerated at the expense of the Shiga bacilli. It behaved like a filtrable organism, a parasite of bacteria. To this principle d'Herelle has given the name bacteriophage, which means an agent causing dissolution of the bacterial cell.

Some interesting theories have been suggested in regard to this transmissible lytic principle. D'Herelle, as has been said, believes that it is a filtrable virus which parasitizes bacteria and causes their destruction by lysis. Bacteriophagy is therefore a contagious disease of bacteria. The infectious unit is an ultramicroscopic and filtrable corpuscle. Bordet and Ciuca [3] have suggested that the phenomenon is an autolysis.

More recently a theory has been advanced by Hadley [4] according to which the bacteriophage is regarded as a stage in the life cycle of a bacterium. When bacteria are in this filtrable form they have the power of inducing other normal bacteria to pass into the same phase.

There are voluminous arguments for each of these theories, and it seems difficult with present knowledge to pick the true one. Regardless of the theory we hold, there are certain evident facts which we know regarding this lytic agent. These are that bacteriophage is a filtrable lytic agent which acts on living bacteria, developing at their expense; it is reproducible in series, and is highly specific in its action toward particular strains of bacteria.

Filtrable principles have been found which cause a lysis of a number of bacteria. The most important of these bacteria are those of plague, typhoid and paratyphoid fever, diphtheria and cholera, and colon bacillus, pneumobacillus, proteus, staphylococcus, streptococcus and gonococcus. There is reason to believe that bacteriophage races exist which are specific for other strains of bacteria also, and attempts are being made to find these lytic agents.

Naturally, one may expect to find bacteriophage present in any material which contains bacteria, especially where bacteria have been abundant for any length of time. It is commonly present in the intestinal tract of normal man and healthy animals, so one may expect to find it in anything which is contaminated with fecal material. It is also found in pus.

Bearing these things in mind, we find city sewage our richest source for bacteriophage. It remains only to separate the phage from the bacteria and other elements present in the sewage. The bacteria are

3. Bordet, J., and Ciuca, M.: Le bacteriophage de d'Herelle, sa reproduction, son interprétation, Compt. rend. Soc. de biol. **83**:1296 (Oct. 9) 1920.

4. Hadley, P.: Microbic Dissociation: The Instability of Bacterial Species with Special Reference to Active Dissociation and Transmissible Autolysis, J. Infect. Dis. **40**:1, 1927; The Twort-d'Herelle Phenomenon, J. Infect. Dis. **42**:263, 1928.

separated from the bacteriophage by filtering through an ordinary bacteriologic filter. The bacteria do not pass through the filter, but the bacteriophage corpuscle, measuring only from 20 to 30 millimicrons, passes through the filter readily and is collected in the filtrate. The dissolved chemical substances become so diluted through subsequent handling of the phage as to become negligible.

The original sewage filtrate obtained is added in 0.5 cc. amounts to 10 cc. of a suspension in broth of a fresh agar culture of the bacteria for which a phage is desired, containing approximately 200,000,000 bacteria per cubic centimeter. This mixture, which constitutes the first generation of phage, is incubated at 37 C. after thorough shaking.

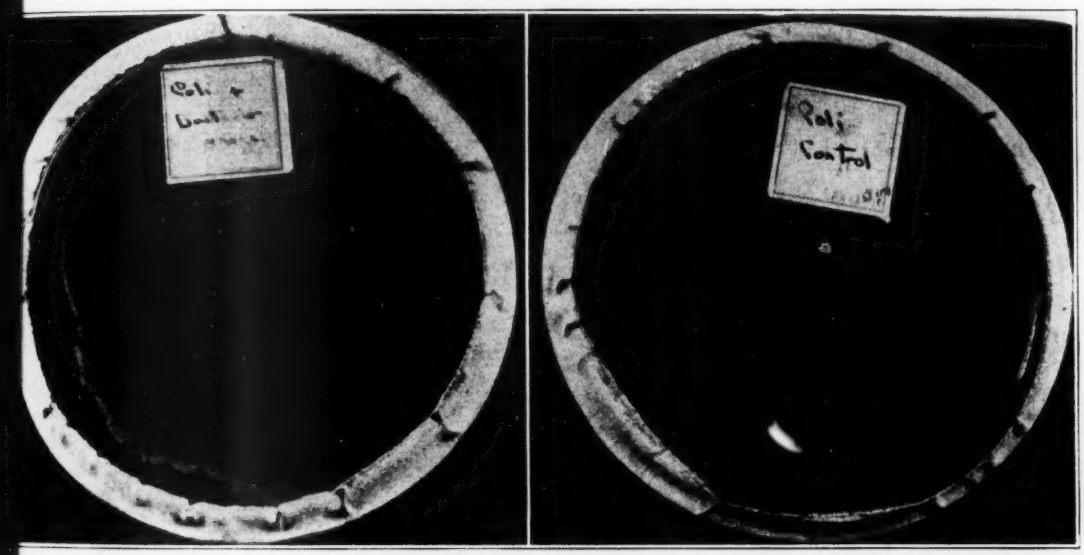

Fig. 1.—The agar plate on the left was streaked with a bacterial suspension to which a small amount of bacteriophage had been added. The clear areas in the growth represent bacteriophage plaques. The agar plate on the right is a control plate streaked with the bacterial suspension to which no bacteriophage was added.

After an appropriate length of time, which should be sufficient for the bacteria to obtain maximum growth, the tubes are read for lysis. One tube which was inoculated only with bacterial suspension is used as a control, and the amount of clearing in the tubes containing the phage is recorded in the terms of 1 plus to 4 plus. The bacteriophage should produce a complete clearing of the broth suspension and should prevent visible secondary growth of the organism for at least twenty-four hours. Sometimes it is necessary to adapt the phage to the organism before it will do this. The procedure is to filter the bacterial suspension which has been inoculated with phage at the time of maximum lysis and to set up a second generation similar to the first, using the filtrate of the

first generation instead of the sewage filtrate. It may be necessary to run several generations before the phage is completely adapted.

Before bacteriophage is used to treat any infection it is wise to isolate the infecting organism, determine its type and test it out in vitro

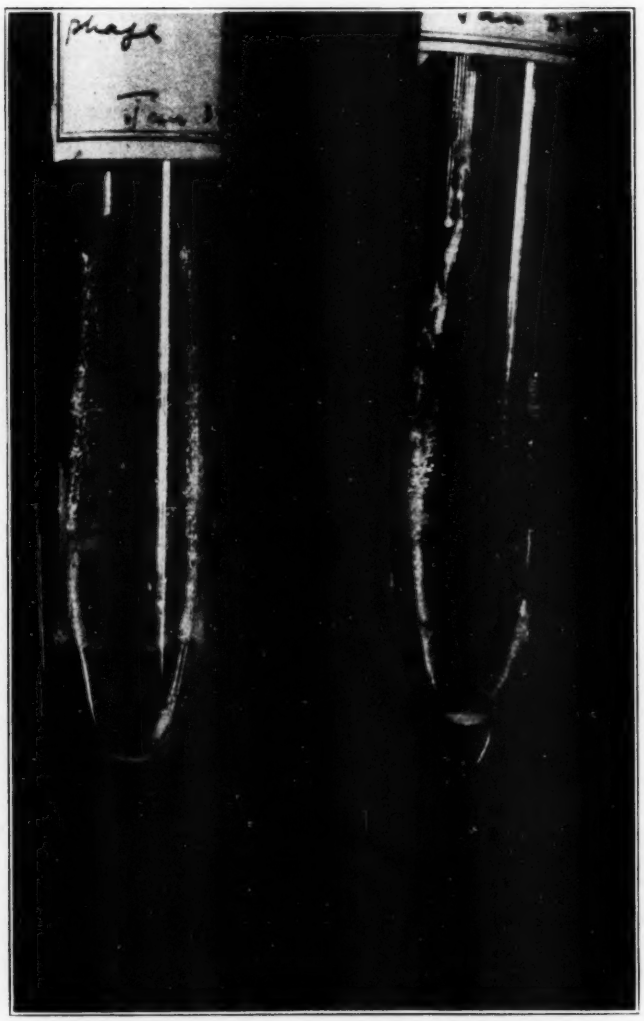

Fig. 2.—The tube on the left is an agar slant streaked with a suspension of Bacillus coli. A platinum needle dipped in bacteriophage was drawn up over the surface. After incubation the bacterial growth appeared, leaving an area without growth where the bacteriophage had been applied. The tube on the right was treated the same way, plain broth being used instead of bacteriophage. No area of clearness was left.

with the corresponding races of bacteriophage kept in stock in the laboratory. These measures insure better results in the use of phage,

because it is evident that it would be useless to employ phage in the treatment of an infection when the infecting organism is completely resistant to the bacteriophage as shown in the test tube. This susceptibility test is set up as when isolating a phage, substituting a known potent race of phage for the sewage filtrate and using the patient's own organism for the bacterial suspension. It is frequently necessary to adapt the phage to the organism by running successive generations.

This testing is made necessary by the fact that the bacteriophage is specific in its action, and there is no other method of determining whether the particular races of phage will work on the infecting organism.

The phenomenon of bacteriophagy has been applied clinically by various workers with good results. MacNeal and Frisbee [5] have reported a series of fifteen cases of staphylococcus septicemia in which the bacteriophage was given intravenously, with recovery in seven cases. Osteomyelitis, which is often due to infection with staphylococcus, has been treated with the aid of bacteriophage by Albee.[6] He no longer uses the open drainage method with surgical solution of chlorinated soda, but uses the closed method of Orr. His theory is that the efficiency of the Orr closed treatment for osteomyelitis depends on allowing the patient to develop his own bacteriophage. When native phage is not present, it is introduced. Rice [7] has reported execellent results in 90 per cent of five hundred cases with phage in the treatment of boils and carbuncles, abscesses, cellulitis, arthritis, fistula, cystitis, ulcer, sinusitis, impetigo and acne. Cipollaro and Sheplar [8] have reported the successful use of bacteriophage in infections of the skin. Hauduroy [9] has reported favorable results with bacteriophage in the treatment of typhoid fever. Since the first reports of d'Herelle, favorable results have been obtained from the therapeutic use of bacteriophage in dysentery, and his results in cholera have been spectacular. Many workers have found staphylococcus infections amenable to bacteriophage, and McKinley [10] and Dutton [11] have supported the value of the streptococcus lytic agent in streptococcus infections.

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5. MacNeal, W. J., and Frisbee, F. C.: Bacteriophage as a Therapeutic Agent in Staphylococcus Bacteremia, Arch. Path. **13**:686 (April) 1932.

6. Albee, F. H.: Will Bacteriophage Prove to be the Ideal Wound Treatment? Am. J. Surg. **15**:228 (Feb.) 1932.

7. Rice, T. B.: The Use of Bacteriophage Filtrates in the Treatment of Suppurative Conditions, Am. J. M. Sc. **179**:345 (March) 1930.

8. Cipollaro, A. C., and Sheplar, A. E.: Therapeutic Uses of Bacteriophage in the Pyodermias, Arch. Dermat. & Syph. **25**:280 (Feb.) 1932.

9. Hauduroy, P.: Le rôle du bacteriophage dans le fièvre typhoïde; sa présence dans le sang, Compt. rend. Soc. de biol. **89**:875, 1923.

10. McKinley, E. B.: The Bacteriophage in the Treatment of Infections, Arch. Int. Med. **32**:899 (Dec.) 1923.

11. Dutton, L. O.: Rôle of the Bacteriophage in Streptococcus Infections: An Interpretation of Certain Cultural Characteristics, J. Infect. Dis. **39**:48 (July) 1926.

With these results in mind, the thought naturally arises, could not bacteriophage be of value in the treatment of ocular diseases? The therapeutic possibilities of an agent normally present in the body and capable of adjusting itself to and propagating at the expense of pathogenic bacteria are obviously worthy of investigation. Our methods are far from perfect, and any addition to the armamentarium of the ophthalmologist should be welcomed. Furthermore, in ocular diseases bacteriophage therapy has an advantage in that it can often be applied topically. We have also injected it locally into lesions of the lids and subcutaneously into the arm. Topical applications are made three times a day, and subcutaneous injections are 1 cc. in amount, given daily. Reactions following the administration of bacteriophage are few and are of little consequence. These reactions are local in nature and limited to the area inoculated. Systemic reactions have not been observed.

In studying each case, the first thing which was always done was to determine whether the organism responsible for the infection was actually lysed by any one of the races of bacteriophage. Only in the event that the responsible organism was completely lysed by a given race of bacteriophage was the resulting lysate employed as a potential therapeutic agent.

A culture of the infecting organism is made by streaking a bit of pus from the infection on the surface of a blood agar plate. A subculture is made of the organism or organisms found, and each one is tested for susceptibility. In the case of a single infection, if the organism is susceptible to the bacteriophage, the proper race of phage is given for use. If a mixed infection is found containing several strains of bacteria, an attempt to obtain a bacteriophage for each kind of bacteria is made, and a mixed bacteriophage is prepared.

Up to the present time we have treated successfully twenty ophthalmologic patients with bacteriophage. Cases in which cultures of the offending organism were not lysed by an available phage are not included in the series.

From the onset, we have been working diligently with cases of dacryocystitis. Here the surgeon is faced with the problem of extirpating the lacrimal sac, which procedure does not give the most desirable results. In our work, it was found that the pneumococcus was the pyogenic organism present in 66 per cent of cases, and as a bacteriophage for the pneumococcus has as yet not been discovered, we were unable to use this new therapeutic agent in these cases. In two patients the infecting organism was the staphylococcus. The treatment was as follows: The lacrimal passages were probed and found to be patent. The sac was then irrigated with physiologic solution of sodium chloride, followed by an irrigation of staphylococcus bacteriophage. In both cases the condition cleared up in about two weeks.

In a young girl with a severe orbital abscess, a culture taken from the pus was rapidly and completely lysed by the staphylococcus bacteriophage. The phage was injected daily into the orbit in 1 cc. amounts, and 1 cc. was injected subcutaneously daily into the arm. The abscess decreased gradually in size, and the inflammation subsided in about two weeks.

Hordeolum seems to offer a most favorable field for bacteriophage therapy, as it is practically always due to the staphylococcus. After a little experience, it was found that the simplest, most efficacious method of treatment is a subcutaneous injection into the arm of 1 cc. of the bacteriophage daily. Two or three injections are necessary to cause a complete recovery. Ten patients, some of whom had recurrent styes, were treated, all with good results.

Meibomianitis is often resistant to ordinary treatment, but is found to be quite amenable to treatment with bacteriophage. Three patients were treated with excellent results. The bacteriophage was injected into the lids and given subcutaneously.

One case of ulcer of the cornea was found in which a culture from the ulcer showed staphylococcus and a culture from an infected tooth showed Staphylococcus aureus and Streptococcus haemolyticus. The bacteriophage was used as a wet dressing and given subcutaneously. The ulcer cleared up in a few days.

One patient with an infected skin graft and three patients with furunculosis about the eye were treated with bacteriophage with good results.

In clinical studies on the therapeutic value of any agent, considerable care must be exercised in interpreting the results obtained. It is quite obvious that our limited series of cases precludes the drawing of any sweeping conclusions as to the efficacy of the bacteriophage in treating infections of the eyes. The prompt recovery which followed the administration of the phage in a few cases, together with the fact that spontaneous recovery may, at times at least, be clearly associated with the appearance of a highly active bacteriophage, tempts one to believe that the bacteriophage may, under certain conditions, play an important rôle in the phenomenon of recovery. It is, however, impossible to say from a small series of observations just how generally such a mechanism comes into play. Judgment should be based on the results of a large series of cases, and not on the results in a few instances. It is only by intelligent, painstaking application that the true value of bacteriophage can be ascertained. It is not enough to treat a staphylococcus infection with a staphylococcus bacteriophage; the specificity for the infecting strain must be determined in the laboratory. The pathogenic organisms must be tested for lysis. Unless bacteriophage is used scientifically with the cooperation of a bacteriologic laboratory, the clinician will be sadly disappointed.

SUBCHOROIDAL HEMORRHAGE DIAGNOSED AS SARCOMA OF THE CHOROID

REPORT OF A CASE

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Detachment of the choroid is a common occurrence after operations for the relief of intra-ocular pressure. It is probably also more frequent after cataract extraction than one realizes, many such cases being overlooked and recovery taking place during the healing process.

Hemorrhage beneath the choroid from like causes also occurs, but its results are usually disastrous, necessitating immediate removal of the eye.

Spontaneous hemorrhage beneath the choroid in an eye with normal tension is an extremely rare condition. The one and only case in my experience during the past twenty years occurred about a year and a half ago:

REPORT OF CASE

A woman, aged 44, married and apparently in good health, except for a moderately high blood pressure, had complained of blurred vision in her left eye for several days previous to the onset of inflammatory symptoms. She went to her regular oculist who saw no definite fundus lesion. The right eye was normal. At that examination the pupils were not dilated. A few days later she returned complaining of increased blurredness of vision in the left eye. At this visit an elevated area was seen in the upper nasal quadrant. The patient was sent home and immediately put to bed, the assumption being that a detachment of the retina had occurred. The following day, severe inflammatory symptoms developed. The eyeball became stony hard, the cornea steamy, the pupil dilated and the ocular conjunctiva chemotic. Deep ciliary blood vessels were widely dilated with stagnant blood. The vitreous was clear. A mass could now be distinctly seen in the location previously described. Transillumination over this area showed it to be impervious to light. A diagnosis of sarcoma of the choroid was made and consultation requested.

I was called. In addition to the foregoing summary of the case as outlined by the attending physician, the following facts were obtained as regards the past history.

The patient's mother became blind before the age of 60, as a result of retinal hemorrhage. Her father died of apoplexy at 55. The patient's general condition had been fairly good, with the following exceptions: She was about 30 pounds (13.6 Kg.) overweight. Her blood pressure had ranged between 150 and 175 millimeters of mercury, and urinalysis showed a slight trace of albumin. The Wasser-

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Read at a Meeting of the New York Academy of Medicine, Section of Ophthalmology, March 21, 1932.

mann reaction of the blood was negative. The menstrual flow had been normal in amount, but somewhat irregular. There had been no spontaneous, subcutaneous hemorrhages. The patient had never been a sufferer from nosebleed.

In 1928, following the extraction of several teeth, she suffered an intermittent loss of blood for four days.

Two weeks previous to the onset of the present ocular symptoms, the patient fell, striking the floor on her right knee. Within twenty-four hours, there was an extensive effusion of blood beneath the skin, both above and below the knee. At that time her physician stated that her blood pressure was 180 systolic and 120 diastolic.

In spite of this history, the diagnosis of the attending ophthalmologist was confirmed, the assumption being that the tumor was present at the first examination, but could not be seen through an undilated pupil. The family being considerably upset, it was suggested that a third consultant be called. This was done and a like diagnosis was made.

Fig. 1.—Drawing made from specimen, after hardening and sectioning, showing large blood clots separating the sclera from the retina and choroid. This detachment involved three fourths of the entire fundus.

The patient was admitted to the hospital for enucleation five days after the onset of glaucomatous symptoms. Blood coagulation time, taken just before operation, was four minutes. Tenon's capsule was found to adhere intimately to the sclera. As soon as the optic nerve was cut, blood began to infiltrate the tissues of the orbit, which finally became so tense and pressure so great as to threaten the vitality of the structures involved. It was with the greatest difficulty that a pressure bandage was applied sufficiently snug and tight to control further oozing of blood.

Four hours later the bandage was saturated with blood. A fresh one was applied, which in turn quickly became saturated. A third bandage was now applied, with firmly applied adhesive strips. After this was reenforced with a second bandage, the bleeding was finally stopped. The dressing was not disturbed for forty-eight hours, and it was thought that trouble from this source had ended. The patient was put on large doses of calcium lactate.

There was no further bleeding, but the tissues remained tense. The patient was allowed to go home on the eighth day. The eye was dressed daily. About the fourteenth day, a final severe hemorrhage took place, which was controlled with the greatest difficulty. Following this, the conjunctiva of the lower fornix became necrotic and the lids cyanotic. It was by a narrow margin that they did not slough.

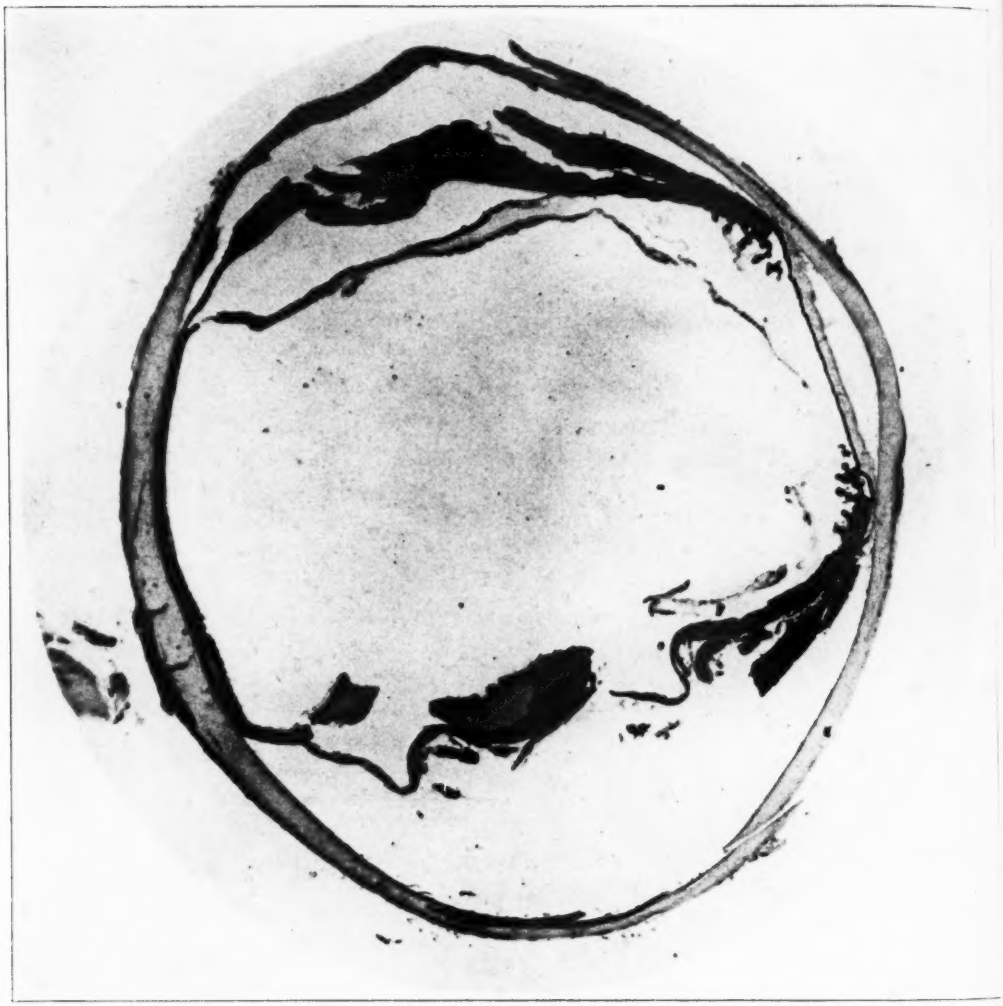

Fig. 2.—Photomicrograph of a section of the eyeball. The large area between the detached choroid and sclera below was filled with clotted blood, which was partly lost in mounting the section.

The final outcome was a contracted socket and an almost complete loss of function of the orbicularis and levator palpebrarum, which were slow in regaining their lost tone. There was at no time the slightest evidence of infection.

It was not until after the eyeball was hardened and sectioned, four weeks later, that the microscope revealed the true nature of the condition. To the natural eye,

the tumor mass presented the appearance of a ring sarcoma and was so diagnosed by one of my confrères.

Serial sections were made, all of which were similar in their essential characteristics. The pathologic report is as follows:

The section showed a large blood clot of recent origin separating the retina and choroid coat, but no tumor was noted. The choroid vessels were congested and showed some hyaline degeneration around the coats. In the center of the clot there were an accumulation of polymorphonuclears and some degenerated fibrin.

The diagnosis was massive annular choroidal hemorrhage.

In conclusion, it is reasonable to assume that due importance was not attached to the patient's previous history in arriving at a correct diagnosis, but owing to the extreme rarity of the condition and its similarity in every detailed physical sign to that of a true sarcoma, the mistake is a justifiable one. As the treatment of both conditions is the same, no harm was done. However, had the eyeball been eviscerated instead of enucleated, the patient might have been spared the unfortunate occurrences which terminated finally in a contracted orbit.

COMMENT

In a review of the literature, I find but few similar cases recorded. Fuchs, in an article in 1925, stated that he had never, to his recollection, absolutely diagnosed choroidal hemorrhage with the ophthalmoscope, though he had occasionally seen it post mortem in the eyes of patients who had anemia.

Parsons mentioned subchoroidal hemorrhage as a cause of glaucoma.

Venneman expressed the opinion that, aside from slight interstitial hemorrhage arising from infectious choroiditis, there is no true spontaneous nontraumatic hemorrhage of the choroid. He thinks that the cases reported have not been confirmed by autopsy.

Demicheri, in 1901, reported a case in a man, aged 35, who had consulted him because of violent pain in the right eye for several days. The patient stated that he had lost the sight of the eye from a serious ocular disease between the ages of 5 and 7 years. When seen by Demicheri the eye was in a state of secondary glaucoma, caused by anterior staphyloma. Section of the enucleated eye revealed a large red hemorrhage between the sclera and choroid. Anatomic examination revealed that it really concerned an intrachoroidal hemorrhage that had become subchoroidal in some places.

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ABSTRACT OF DISCUSSION

Dr. Martin Cohen, New York: Hemorrhages are frequent in small sarcomas. Serial sections should be made before one rules out sarcoma.

Dr. Bernard Samuels, New York: It never occurred to me that subchoroidal hemorrhage could occur without the eyeball being opened. The behavior here is just exactly like that in postoperative subchoroidal hemorrhage with respect to pain and increased tension. All eyes suffering from subchoroidal hemorrhage of any great extent are lost from glaucoma.

Dr. A. A. Eggston, New York: Because of the desire to save a portion of the eye for mounting, only one half of the eye was serially sectioned. No tumor was found in the sections made.

Dr. Clyde E. McDannald, New York: Did not Meller report a case in which he enucleated an eye for subchoroidal hemorrhage, thinking it was sarcoma?

Dr. L. W. Crigler: My main object in reporting the case was to show the similarity of the condition to a tumor of the choroid, which is nearly always sarcomatous. The congestion and hyaline degeneration of the vessel walls would seem to indicate the true cause of the hemorrhage.

TRANSPORTATION OF PARTICULATE MATTER FROM THE VITREOUS INTO THE OPTIC NERVE

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JOSÉ F. NONIDEZ, D.Sc.
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The use of silver carbonate as a stain for the retina has shown that the internal limiting membrane of this organ appears as a close meshwork of fibers (Berliner [1]), probably formed by branches of Müller's fibers and retinal astrocytes.

To ascertain whether or not this membrane would allow the passage of particulate matter into the retina we injected india ink into the posterior portion of the vitreous. The injections were made as soon as the needle was seen ophthalmoscopically to have perforated the retina, in such a way that the injected material tended to spread over the surface of the retina.

It was found that injected particles did not cross the internal limiting membrane, but that they were promptly removed by active phagocytic cells coming from the optic nerve and entering the vitreous.

Rabbits were used for the experiments. Some were albinos and others were gray or black. The presence of pigment in the latter did not in any way interfere with the study of the mechanism of transportation and elimination of the injected ink, for it was found that melanophores could be easily distinguished from the phagocytes carrying the particles of ink. When 1 minim (0.06 cc.) of ink was injected, no disturbances were observed in the eye, the ink being completely removed within five or six days. The injection of larger amounts of ink (from 3 to 4 minims [0.18 to 0.24 cc.]) caused a marked reaction in the eye soon after the injection. The vitreous body became cloudy, and there was marked iritis with increased intra-ocular tension. The opacity of the vitreous increased gradually until it was impossible to examine the fundus with the ophthalmoscope.

Although some rabbits were kept alive for long periods after the large injections, recovery never took place; these eyes were permanently injured. At autopsy it was found that, in addition to a heavy infiltra-

From the Department of Anatomy, Cornell University Medical College.

1. Berliner, M. L.: Cytological Studies on the Retina: I. Normal Coexistence of Oligodendroglia and Myelinated Nerve Fibers, Arch. Ophth. **6**:740 (Nov.) 1931.

tion of cells in the vitreous, there was in most cases detachment of the retina. It was also noticed that the reaction set up by the injection of large amounts of ink was more pronounced, and appeared more readily in the albino rabbits.

The conjunctiva was anesthetized with cocaine before the injection. Under aseptic precautions the needle was inserted as far back as possible, to avoid injury to the ciliary body and possible dislocation of the lens. In some cases the ink was prepared immediately before the injection, solid ink being dissolved in distilled water and sterilized. In others a commercial fluid ink was injected. As long as a minim of ink was injected, no toxic effect was noticed. The reaction following the injection of larger amounts (3 or 4 minims) was due, in all probability, to an increase in intra-ocular tension rather than to increased toxicity of the injected material, the signs closely resembling those characteristic of acute glaucoma.

After variable intervals following the injections the animals were killed and the eyes, including the optic nerves and chiasm, were fixed. Heidenhain's sublimate-formaldehyde-trichloracetic mixture was used in most cases. Bouin's fluid with an equal part of saturated aqueous solution of sublimate gave good results in others. The stains used were Grenacher's alcoholic carmine for mass staining and Ehrlich's hematoxylin for the staining of nuclei in sections. The optic nerve and part of the posterior surface of the eye were carefully embedded in paraffin and cut into serial sections (from 8 to 10 microns thick). The optic chiasm was also prepared in the same way, and sectioned in the horizontal plane.

A condensed account of the experiments follows:

EXPERIMENTS

RABBIT 1.—A minim of ink was injected into both eyes at different intervals. The animal was killed four days after the first injection, one day after the second injection. There was no reaction following the injections. The india ink was completely removed from the eye in which an injection was made four days before autopsy.

RABBIT 2.—Ink was injected into both eyes. There was a slight reaction in both. The animal was killed one day after the injection.

RABBIT 3.—A large amount of ink (from 3 to 4 minims) was injected into the right eye; this was followed by strong reaction. The left eye was given an injection (1 or 2 minims [0.06 to 0.13 cc.]) five days later. The animal was killed eight days after the first injection and three days after the second injection. A moderate reaction in the left eye was observed.

RABBIT 4.—A large amount of ink (3 or 4 minims) was injected into the left eye. There was a marked reaction, with iritis. A small amount was injected into the right eye. Part of the fundus was grayish white, suggesting partial detachment of the retina. The animal was killed eighty-seven days after the first injection and sixteen days after the second.

Fig. 1.—Sagittal section of the optic nerve and nerve head of an albino rabbit (rabbit 3), three days after the injection of a small amount of india ink into the posterior regions of the vitreous body. The section shows the entrance of the central artery (*a*) and central vein (*v*) into the optic nerve. Around these vessels there are numerous histiocytes, many of which are loaded with ink particles; *vb*, a part of the vitreous body adhering to the excavation of the nerve head. Sublimate-formaldehyde-trichloracetic acid-fixation. Nuclear stain with hematoxylin.

RABBIT 5.—A large amount of ink was injected into both eyes on the same day, with a strong reaction. Autopsy was performed two days and eighteen hours after the injection.

RABBIT 6.—A large amount of ink was injected into the right eye. A strong reaction resulted. The animal was killed forty days after the injection.

RABBIT 7.—A minim of ink was injected into the left eye. No reaction was present. A second injection was made seven days later. There was no reaction; the fundus was normal, but the lens appeared dislocated. The animal was killed twelve days after the first injection and five days after the second injection.

RABBIT 8.—The left eye was given an injection of ink, a greater amount than was used in rabbit 7. There was a severe reaction in that eye and some reaction in the other (right) eye. An injection was made in the right eye. The animal was killed forty-eight days after the first injection and twenty-one hours after the second injection.

I. REMOVAL OF PARTICLES AFTER INJECTION OF A MINIM OF INDIA INK

The observations on the removal of the ink in eyes in which the injection was not followed by any outward visible reaction are based on the study of serial sections of the optic nerve and retina of three rabbits (nos. 1, 2 and 7). The case of a fourth rabbit (no. 3) in which there was moderate reaction will also be considered here.

Examination with the ophthalmoscope at the time of the injection or immediately afterward disclosed the ink as a sharply circumscribed black spot, slowly spreading in a thin layer and gradually advancing toward the nerve head. After twenty-four hours the ink appeared as a dark gray spot occupying a relatively large area over the disk and contiguous retina. In the following two or three days the dark gray color had turned into a light reddish gray. A day or two later no ink could be detected in the fundus except perhaps a minute speck at the bottom of the disk. In animals allowed to live four days or longer no ink could be detected anywhere in the fundus, the vitreous appearing as transparent as in the normal eye.

Removal of the ink is effected by migrating cells that reach the vitreous by traveling along the perivascular connective tissue which surrounds the central vessels in the optic nerve. After engulfing ink particles in the vitreous the phagocytic cells return to the perivascular connective tissue, carrying their load to the pial and dural sheaths of the nerve (fig. 1).

As will be remembered, the central artery and vein, as they enter the optic nerve, carry along with them a sheath continuous with the pia surrounding the nerve. In normal eyes the pial sheath around the vessels consists of delicate connective tissue fibers, running more or less parallel to the axes of the vessels, and a few fibroblasts. On account of the contraction of the artery after death and the shrinkage of the

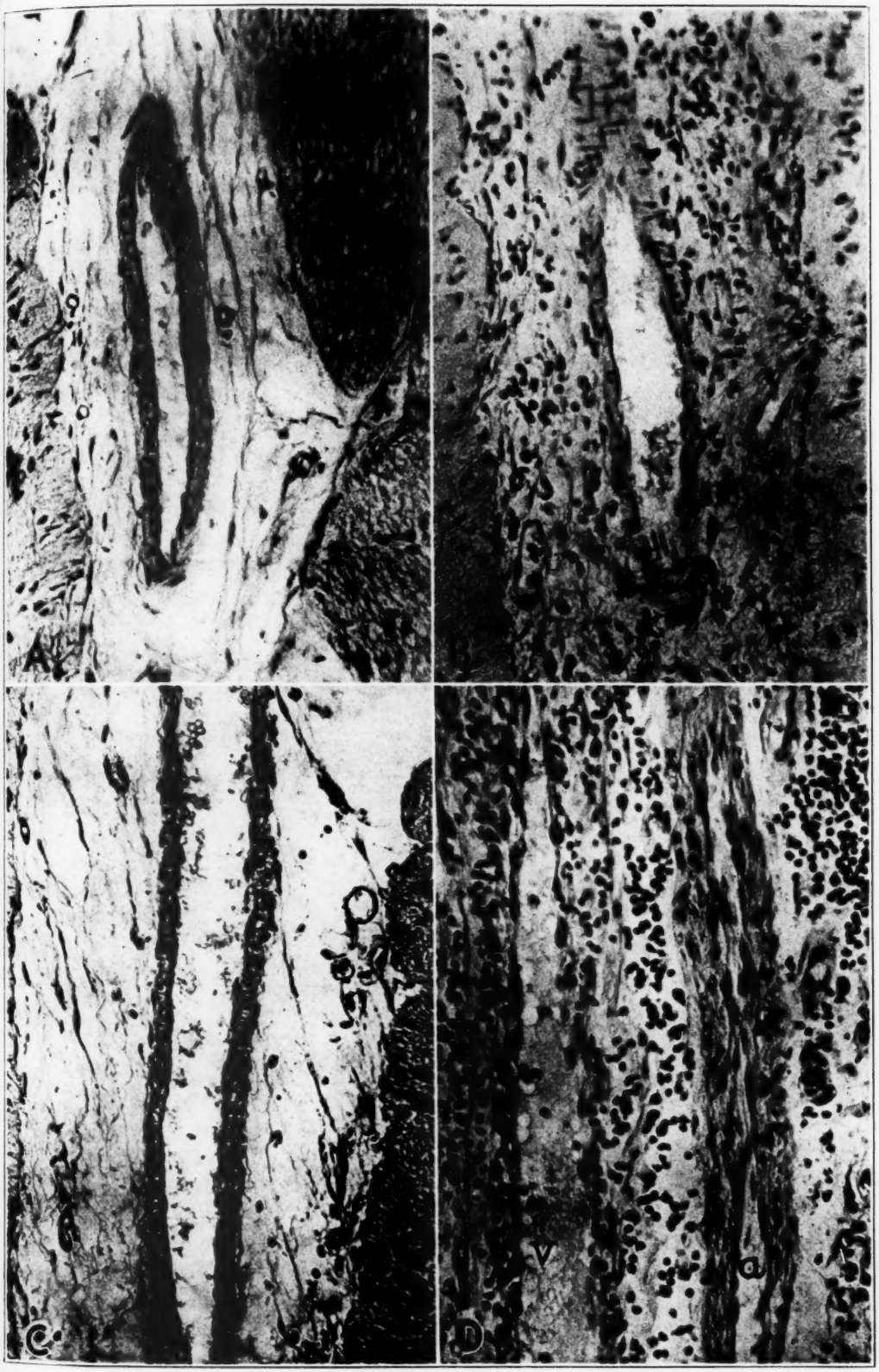

Fig. 2.—*A*, longitudinal section of the central artery in the optic nerve of an eye not given an injection (rabbit 7). *B*, section of the central artery in the nerve, three days after an injection (rabbit 3). *C*, central artery in the nerve of an eye, five days after an injection. Notice the normal aspect of the perivascular connective tissue (rabbit 7). *D*, central artery (*a*) and vein (*v*) in the optic nerve of an eye, forty days after the injection of a large amount of india ink. Some cells are still loaded with particles of ink (rabbit 6).

nerve bundles during the processes of dehydration and embedding, the spaces between the connective tissue fibers surrounding the vessels are considerably increased in size (fig. 2 *A*). It is questionable, in fact, whether there is a true perivascular space or whether there is simply loose connective tissue with its fibers oriented in such a way that they will easily allow passage of migrating cells. With the exception of a few fibroblasts among the connective tissue fibers no other cells are visible around the vessels in normal rabbits' eyes.

In rabbits in which the eyes have been given injections of india ink the perivascular connective tissue of the nerve on the side of the injection contains large numbers of cells. Some are small and roundish, and do not contain particles of ink in their cytoplasm, while others are loaded with ink.

From our observations we may conclude that the small, round cells are young phagocytic elements on their way to the vitreous. Similar cells occur in the latter (fig. 3 *r*). The cells under consideration closely resemble lymphocytes. However, when studied under an immersion lens it can be seen that they do not possess typical lymphocytic nuclei, but contain a network of chromatin which is not condensed into large blocks or particles. Their nuclei are often somewhat irregular in outline.

Slightly larger cells with similar nuclei and more abundant cytoplasm also occur in the vitreous (fig. 3 *l*). Their cytoplasm is finely granular and of irregular contour, and may contain a few engulfed particles of ink. As these cells grow, their nuclei become more irregular and may show lobulations. The cytoplasm contains more particles of ink and large vacuoles. A few cells, gliding along the fine fibrillar material that separates the layers of the vitreous, may appear quite elongated and closely resemble fibroblasts (fig. 3 *e*). They also contain engulfed particles of ink.

The characteristics just mentioned permit the identification of the phagocytic cells as typical histiocytes wandering into the vitreous. In eyes receiving only a minim of ink leukocytes are rare in the vitreous, but they are much more numerous in eyes in which larger amounts of ink have been injected.

A careful study of the perivascular connective tissue of the optic nerve shortly after the injection of ink into the posterior portion of the vitreous body shows that this is the main route utilized by the young histiocytes both on their way toward the vitreous and on their return after having engulfed particles of ink. There are, therefore, two cell streams running side by side in opposite directions. One is represented by elements traveling toward the vitreous, about to perform their phagocytic function, while the other consists of cells which, after

engulfing particles of ink, transport them through the perivascular connective tissue toward the pial sheath surrounding the nerve. Since the perivascular connective tissue is continuous in many places with trabeculae arising from the pial sheath, it is not surprising to see ink-laden cells following these trabeculae. These cells, however, are not

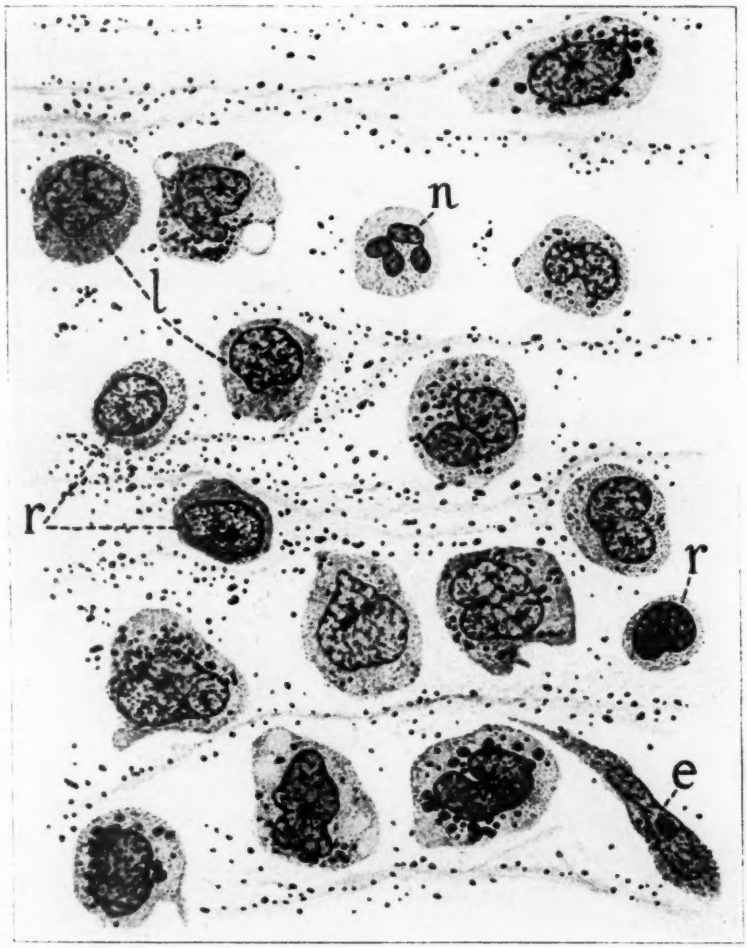

Fig. 3.—Phagocytosis of particles of ink in the vitreous body (rabbit 3) three days after an injection. The part represented corresponds to the part of the vitreous seen in figure 1 *vb*. The cells copied are more crowded in the figure than they were in the actual section in order to show as many cells as possible: *e*, elongated (migrating) histiocyte; *l*, young histiocytes representing a later stage than the small histiocytes labeled *r*; *n*, neutrophilic leukocyte. Zeiss apochr. hom. imm. 90, ocul. K 15.

as numerous as would be expected, and most of them soon disintegrate. In this way ink particles are released in the pial septums. Ink-laden cells migrating among the nerve fibers were never seen by us. Their

passage among the nerve fibers would be prevented by the close meshwork formed by the prolongations of the glia cells.

The migration of the ink-laden histiocytes along the perivascular connective tissue is clearly seen in figures 1 and 2*B*. A drawing under the immersion lens is seen in figure 4. Young histiocytes are observed in this figure. They are comparatively smaller than the corresponding elements that have reached the vitreous.

Cells loaded with ink particles, in the perivascular connective tissue, vary in size. The largest have clear, vesicular nuclei. The amount of phagocytosed ink in the cytoplasm of these cells is also variable. Some elements contain numerous coarse particles, while others carry only small granules (fig. 4*s*). In addition to the ink contained within the cytoplasm of the histiocytes there are free ink particles in the perivascular tissue. These we interpret as having been released by histiocytes dying or disintegrating while traveling toward the periphery of the nerve. These particles are taken up eventually by young histiocytes or even by cells in the arterial adventitia (*a*). Masses of ink particles crowded together and surrounded by a thin protoplasmic film (*i*) belong to histiocytes so placed that their nuclei are not included in the section. The few fibroblasts present in the perivascular connective tissue do not contain phagocytosed ink in their cytoplasm (fig. 4*f*). Elongated cells resembling fibroblasts and containing ink particles are, as in the case of the vitreous, histiocytes gliding along connective tissue fibers.

As the cells containing ink approach the periphery of the nerve they appear more crowded. A good many cells do not continue their migration along the central vessels, but enter the pial sheath, traveling among the connective tissue fibers of the latter for varying distances (fig. 5). Other ink-laden histiocytes eventually enter the dura. Such cells appear considerably elongated as they travel among the stout connective tissue fibers that form this sheath. No histiocytes containing ink were seen entering the subarachnoidal and subdural spaces. Most of the cells not entering the pia and dura proceed along the perivascular connective tissue and are apparently lost among the tissues that fill the space between the eye and the walls of the orbit.

The migration of young histiocytes toward the vitreous and their return, loaded with particles of ink, do not seem to have a deleterious effect on the perivascular connective tissue. In fact, the fibroblasts present in this tissue do not proliferate, nor is there fibrosis. After complete removal of the ink from the vitreous, the perivascular connective tissue appears normal, as demonstrated by figure 2*C*, which shows the artery and perivascular tissue five days after the injection of a minim of ink. In connection with this figure it must be stated

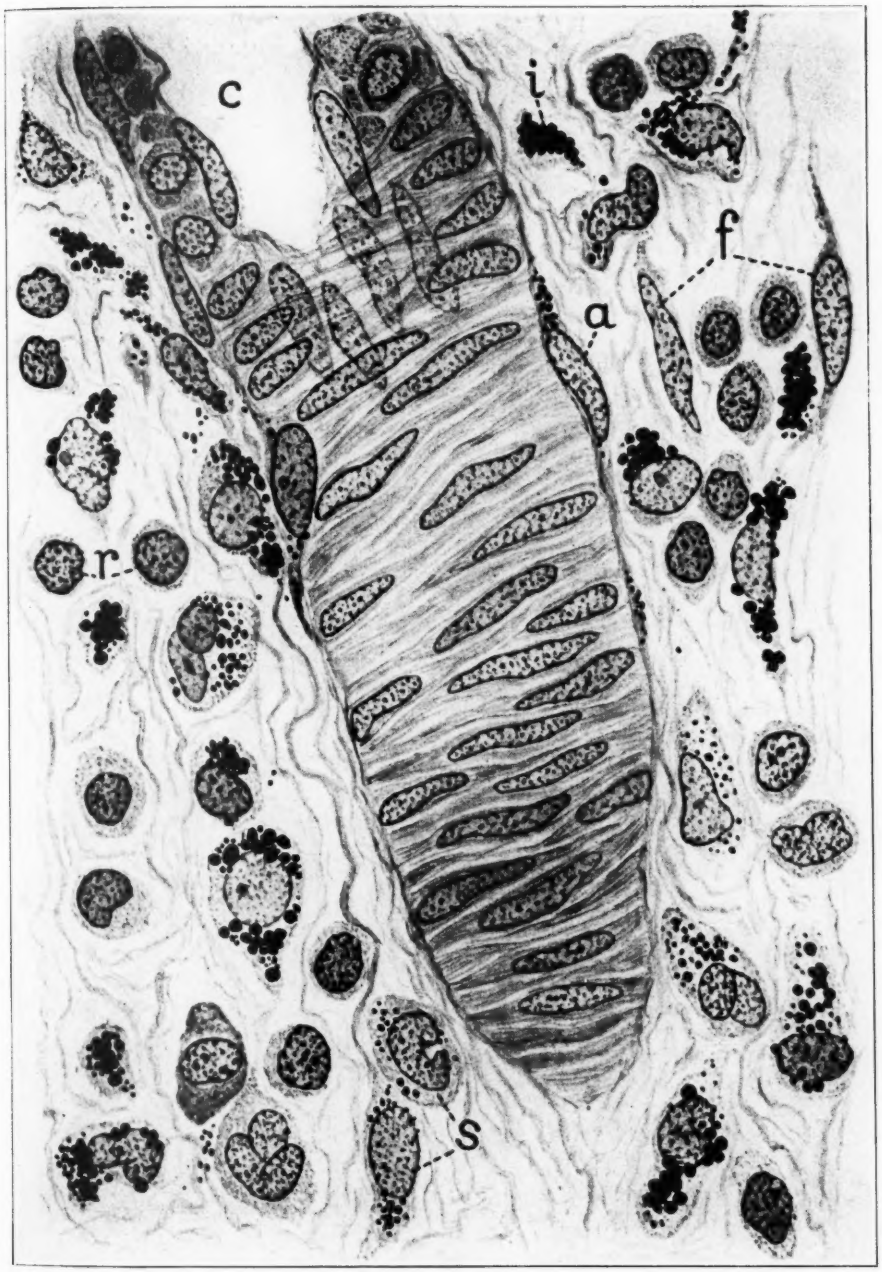

Fig. 4.—High power drawing showing transportation of particles of india ink by histiocytes along the perivascular connective tissue (rabbit 3, three days after the injection): *a*, adventitial cell containing particles of ink; *c*, central artery; *f*, fibroblasts; *i*, particles of ink in the cytoplasm of a cell, the nucleus of which was not included in the section; *r*, small, round histiocytes; *s*, cells containing small particles of ink in the cytoplasm. Zeiss apochr. hom. imm. 90, ocul. K 15.

Fig. 5.—High power photomicrograph of the area enclosed within the rectangle in figure 1, showing the passage of ink-laden histiocytes into the pial (*p*) and dural (*d*) sheaths; *a*, central artery as it enters the optic nerve.

that the rabbit in this instance had received a previous injection in the same eye, the ink having been completely removed before the second injection was made.

While the processes described could be interpreted with a reasonable degree of certainty, the origin of the histiocytes entering the vitreous is obscure. There are two points which we desire to emphasize: (1) that these phagocytic cells do not represent elements that have migrated from the vessels, and (2) that they are not glial cells. This consequently excluded the possible proliferation and mobilization of the microglia.

At present the only interpretation which we can advance is that the phagocytic cells are histiocytes arising, in all probability, from clasmatocytes in the connective tissue of the pia and pial septums and in the adventitia of the arteries. This, however, does not completely exclude the possibility that the histiocytes may arise in small lymphoid patches located among the tissues filling the orbit, and that many of the ink-laden cells may return to these patches. The latter would be, in fact, similar to the "milky spots" (*taches laiteuses*) of the mesentery, which represent nodules or aggregations of elements capable of transformation into histiocytes under the influence of definite stimuli.

In concluding this description of the removal of small quantities of ink injected into the posterior portion of the vitreous, we wish to emphasize again the fact that the ink-laden histiocytes follow a definite pathway and do not enter the retina; nor do they migrate between the fibers of the optic nerve. Sections of the chiasm have shown that the histiocytes bearing particles of ink never reach this region. On the other hand, sections of the eye in which no injection was made similarly indicate that no ink-laden histiocytes reach this eye or even penetrate the optic nerve.[2]

II. REMOVAL OF PARTICLES AFTER INJECTION OF A LARGE AMOUNT OF INK INTO THE POSTERIOR PORTION OF THE VITREOUS BODY

The processes of removal of particles after the injection of larger amounts of ink (3 or 4 minims) into the posterior portion of the vitreous are complicated, as already stated, by an inflammatory and glaucomatous reaction which sets in shortly after the injection and lasts several months. The first changes noticeable are iritis, progressive

2. This is at variance with recent findings by Krug (Krug, E. F.: An Investigation of the Ferment Activity of the Rabbit's Vitreous, Tr. Am. Ophth. Soc. **29**:451, 1931), who has observed the passage of fat droplets from one eye to the other via the optic chiasma.

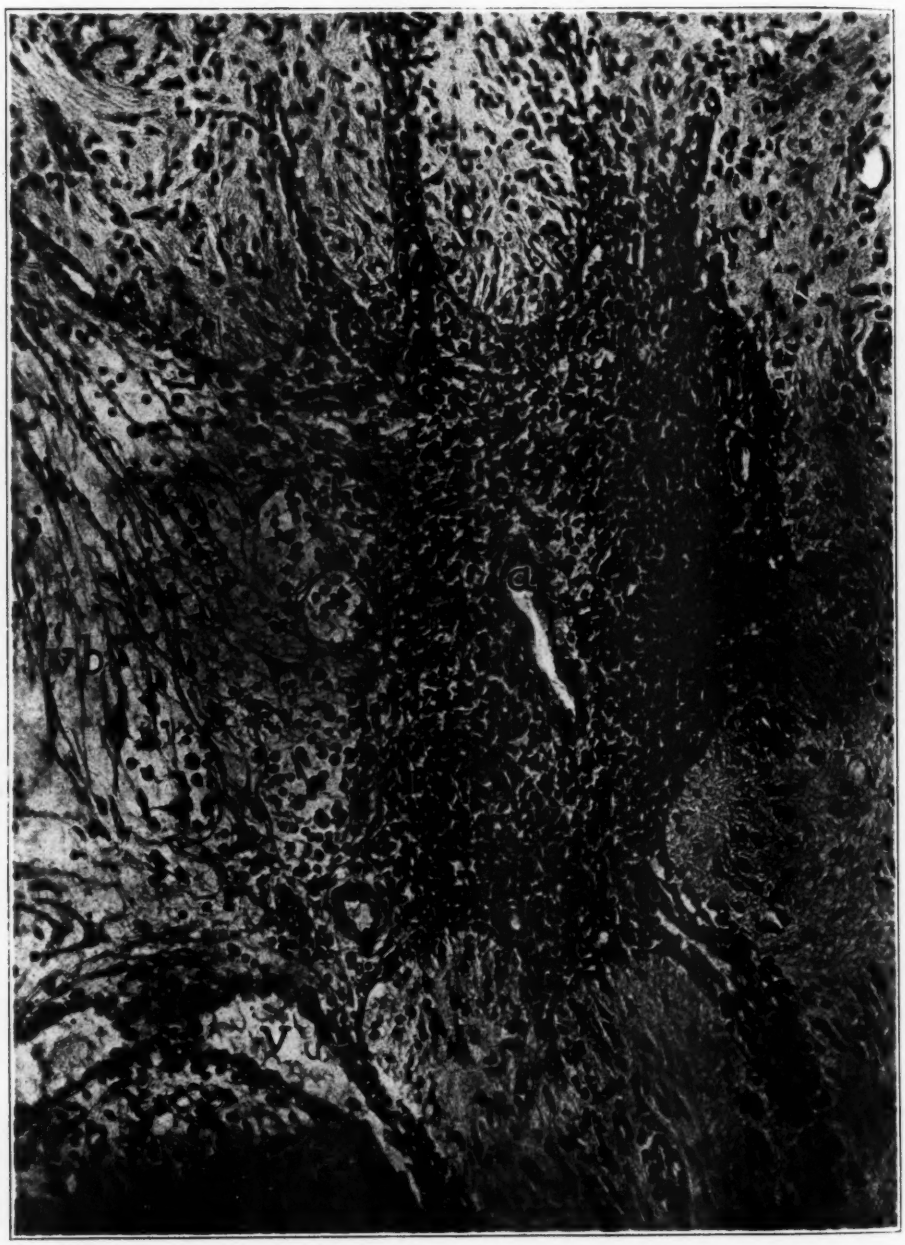

Fig. 6.—Photograph showing heavy infiltration of the excavation in the nerve head after injection of a large amount of india ink into the vitreous (rabbit 6, forty days after the injection): *a*, branch of the central artery; *v*, central vein; *vb*, vitreous body. Many histiocytes in the latter are loaded with particles of ink.

cloudiness of the vitreous and increased intra-ocular tension. Detachment of the retina may also occur. After a few days the vitreous becomes opaque, and it is no longer possible to examine the fundus.

Sections of the posterior region of the eye, including a portion of the infiltrated vitreous, disclose the presence of enormous numbers of cells similar to those described in cases of injection of a minim of

Fig. 7.—Longitudinal section of the optic nerve, close to the chiasm, of an eye given an injection. Notice the absence of india ink in the nerve proper and in the pial sheath (rabbit 7, forty days after the injection).

ink. In addition there are numerous neutrophilic leukocytes and, in some instances, eosinophils. Lymphocytes may also be present.

In a general way it may be said that the histologic picture is one of active phagocytosis of ink particles and a simultaneous inflammatory reaction. Since the amount of ink injected was much larger than in the preceding cases, its removal required a longer time. Cells loaded with

ink may be seen weeks after the injection (figs. 2 *D* and 6). But even after most of the ink has been removed, the migration of cells into the vitreous continues unabated. The path followed by the migrating elements is essentially similar to that utilized by the phagocytic cells when no reaction is present. The only difference is that in those cases in which a large amount of ink has been injected, the migration of the phagocytes is not limited to the perivascular connective tissue around the central vessels, but is also observed around the smaller branches of these vessels.

Figure 6 is a photomicrograph of the nerve head of a rabbit forty days after the injection of a large amount of ink. It will be noticed that the retinal branches of the central vessels are embedded in a mass of round cells. The latter occur in large numbers in the perivascular connective tissue around the smaller branches of the central vessels, and they may even migrate among the bundles of the optic nerve fibers as the vessels pass into the retina. Cells containing ink are still found in the excavation of the nerve head.

From these facts it is clear that the injection of a large amount of ink into the posterior region of the vitreous calls forth the usual migration of histiocytes. At the same time, through an increase in intra-ocular tension the injection produces a series of disturbances which cause permanent injury to the eye. The enormous increase in phagocytes does not visibly interfere with removal of the ink from the vitreous, though it may retard it considerably.

Almost without exception the injections caused detachment of the retina in our rabbits, through the accumulation of subretinal fluid.

However, there was no marked reaction of the retinal glia. The same is true of the glia of the optic nerve. Atrophy of the retina and optic nerve may cause glial proliferation and ultimately result in fibrosis. In no case were particles of ink observed in the retina of any of the eyes given injections.

COMMENT

The results of our experiments differ somewhat from reports of similar work found in the literature. According to Nuel and Benoit,[3] india ink injected into the vitreous of the rabbit passes directly into the perivascular spaces around the central vessels in the optic nerve. Our observations clearly indicate that such is not the case, and in this respect we agree with Evans,[4] who has repeated the experiments of

3. Nuel, J. P., and Benoit, F.: Des voies d'élimination des liquides intra-oculaires, Arch. d'opht. **20**:161, 1900.

4. Evans, J. N.: Retinal Perivascular Delineation, Arch. Ophth. **6**:823 (Dec.) 1931.

the authors mentioned. Perhaps Nuel and Benoit used high pressures during the injections, thus producing artificial spaces in the tissues. In our cases the injected ink never entered the optic nerve directly, even in those instances in which enough ink had been forced into the eye to cause increased intra-ocular tension.

Our observations, however, do not agree entirely with those reported by Evans, since we have not been able to confirm the presence of histiocytes loaded with particles of ink in the nerve fiber layer of the retina, nor have we been able to detect the same cells among the individual nerve fibers of the optic nerve. While it is true that there are no lymph channels or spaces communicating directly with the vitreous of the rabbit, there is no question that there exists a definite pathway for the passage of the histiocytes after the latter have engulfed particles of ink in the vitreous.

That no india ink passes into the retina or is delivered into this organ by the histiocytes is in contrast with recent observations by Friedenwald and Chan,[5] who have found that melanic pigment from the eyes of animals injected into the vitreous of albino rabbits is ultimately delivered into the retina, where it is phagocytosed by Müller's fibers. Apparently, melanic pigment, although taken up by histiocytes, is not eliminated via the optic nerve, but remains within the eye for long periods. This may be due to the fact that melanic pigment is not a substance foreign to the eye, as is the case with india ink.

We are inclined to question Evans' statement that "particulate staining is not adaptable to a study of the lymph flow in the sense of dissemination by stream flow, because the tissue cells pick up particles and apparently wander through certain retinal structures without reference to hypothetic or actual channels." This author seems to confuse two essentially different facts, namely, (1) the passive penetration of particulate matter into preformed channels and (2) the ultimate fate of the injected material. Thus, for example, a very small amount of india ink introduced in a lymphatic will soon enter the sinuses of some of the nodes in the vicinity. It will remain in the sinuses if the animal is killed soon after the injection, but will be phagocytosed by histiocytes and ultimately transported into the parenchyma of the node if the animal is allowed to live. Phagocytosis of the particles in this case could not be used as an argument against the continuity of the lymphatic and the sinuses of the node, for the direct

5. Friedenwald, J. S., and Chan, E.: The Pathogenesis of Retinitis Pigmentosa with a Note on the Phagocytic Activity of Müller's Fibers, Arch. Ophth. **8**:173 (Aug.) 1932.

penetration of the ink in the latter is in itself convincing proof of the existence of definite channels for the flow of the lymph through the node.

It seems to us that the failure of the ink to enter the hypothetic perivascular space surrounding the central vessels in the optic nerve, soon after the injection, is perhaps the best proof that this space does not actually exist as such, its place being taken by a system of irregular interstices between the fibers of the perivascular connective tissue.

REPAIR FOLLOWING OPERATIONS ON THE EXTRA-OCULAR MUSCLES

HISTOLOGIC OBSERVATIONS

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Since John Friedrich Dieffenbach first successfully treated strabismus by tenotomy in 1829, considerable literature has accumulated concerning operations on the extra-ocular muscles. But, so far as we are aware, little or no study has been made of repair following operation, probably because of the impossibility of obtaining sufficient human material. Such a small number of patients die within a few days or weeks after these operations that it would be most difficult to obtain adequate gross and microscopic data; and when the patients do die years later, it must be indeed a rare happening for a pathologist to examine the extra-ocular muscles and their attachments.

And so, to study this problem several simple procedures were devised. The experimental animal, an adult rabbit, was given sodium amytal or pentobarbital sodium intraperitoneally. During the first year's experiments the dose of anesthesia sufficient to enable us to work on ocular muscles and the fatal dose seemed to be so close that there resulted a 50 per cent mortality due to anesthesia. A rabbit, even after full doses of the drugs used, appears to react reflexly by jerking away the head when any stimulus is applied to the extra-ocular muscles. But for the past year all these difficulties have been overcome by an easy method of preventing any motion of the animal's head during operation. The head was placed sidewise on a 25 pound iron block containing an excavation the size of a golf ball so that the eye not being operated on was over the dug-out area. Then a canvas "corset" with an opening just large enough to operate through was put around the iron weight so that the opening was over the uppermost eye, and the three broad straps of the corset were pulled tight. No motion of the animal was possible, and a safe dose of intraperitoneal anesthesia was given without a single fatality.

Then 4 per cent cocaine was dropped into the conjunctival sac, and, with the ordinary clean technic, the operations subsequently described

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were performed. From two to forty days thereafter the animals were killed by electrocution or ether, and the eyes and eye muscles were examined immediately and placed in a diluted solution of formaldehyde, U. S. P. (1:10). Later, sections were taken and stained with hematoxylin and eosin, Mallory's connective tissue stain or the Van Gieson stain. For the purpose of these experiments any of the extra-ocular muscles could be employed. Since in the rabbit the superior rectus, inferior rectus and inferior oblique appeared the largest they were used.

SIMPLE TENOTOMY

(Muscle not reattached with sutures)

Seventeen simple tenotomies were carried out. The method was to open the conjunctiva over the insertion of the muscle, cut completely

Data on Seventeen Cases

Case	Days After Operation	Attachment
1	2	Moderately firm
2	2	Very loose (broke)
3	2	Moderately firm
4	4	Loose
5	4	Moderately firm
6	6	Loose
7	6	Very loose (broke)
8	8	Very loose (broke)
9	8	Was not attached to eyeball
10	10	Firm
11	10	Firm
12	12	Loose
13	12	Very loose (broke)
14	14	Moderately firm
15	14	Very loose (broke); a few lateral attachments of this muscle had not been cut at operation
16	21	Firm (see fig. 1A)
17	40	Firm (see fig. 1B)

across the muscle close to the sclera and sever also the lateral attachments. In about half the cases no sutures were placed in the conjunctiva; in the others it was closed with fine silk.

POSTMORTEM OBSERVATIONS

Gross.—The conjunctiva had no openings in it regardless of whether sutures had or had not been used, but occasionally if the edges were not approximated small pockets due to adhesions were found near the retrotarsal fold. In all cases except one, the muscle was found attached farther back on the eyeball. In that instance a resection had been performed on the opposing muscle. The tenotomized muscle was found back of the globe and had no connection to it. In another case not included in this series the muscle was cut across 4 mm. from its insertion rather than at the sclera, and this muscle also failed to attach. An effort was always made to determine roughly the firmness of the reattachment, and therefore the muscle was picked up with forceps behind the globe and gently pulled. Several times the slight force occasioned by merely grasping the muscle caused it to break loose from the sclera. A summary of the findings in each case is given in the table.

Comment.—It would perhaps be interesting accurately to test the tensile strength of the attachment,[1] but more crude tests were sufficient to show definitely that there was frequently no correlation between the number of postoperative days and the firmness of the attachment. This was apparently due in some instances to the adhering of the muscle to loose episcleral tissue, but more frequently to the failure of the blood clot produced at operation to keep the muscle in close approximation with the sclera during the first few days after operation until new connective tissue formed.

Microscopic.—Unless the tendon is transected close to its insertion, myotomy rather than tenotomy is performed. We were surprised to find on histologic examination after operation that we frequently had cut muscle fibers rather than tendons, even though the "tenotomy" was at the point of insertion. This was probably due to the shortness of the tendons. For reasons subsequently given it was not determined whether attachment following myotomy was apt to be more

Fig. 1.—*A,* simple tenotomy of the superior rectus and superior oblique twenty days after operation, showing reattachment. The dark shadow is cast by the stub of the superior rectus remaining at the original point of insertion. *B,* simple tenotomy forty days after operation, showing firm reattachment 8 mm. back of the original insertion.

firm than that following tenotomy. Since the gross picture showed no regularity, one is not led to expect any in the microscopic.

Second Postoperative Day: The only connection between the muscle and the sclera was some loose episcleral connective tissue which contained in its meshes a few proliferating fibroblasts, a considerable amount of hemorrhage consisting of many red blood cells and fibrin, an occasional necrotic muscle fiber and a scattering of polymorphonuclear leukocytes. There was no evidence of granulation tissue. In fact, the attachment was most unsubstantial in appearance (fig. 2).

Fourth Postoperative Day: The number of fibroblasts had tremendously increased. With the Mallory stain, as employed, the spindle-shaped cell body and nucleus of the fibroblasts were pinkish red, while the new connective tissue fibrils at either end of the spindle were light blue. In addition, there were numerous capil-

1. Howes, E. L., and Harvey, S. C.: Internat. J. Med. & Surg. **43**:225 (April) 1930.

laries. The fibrin present in large amounts was furnishing an admirable latticework to support and guide the direction of growth of the new tissue.

Sixth Postoperative Day: Interposed between the end of the tenotomized muscle and the sclera was loose fragile episcleral tissue containing a sparse collection of fibrin, red blood cells and polymorphonuclear and round cells, as well as occasional fibroblasts. A moderate amount of new connective tissue was present at the end of the cut muscle, but the important thing to note was that it was not in contact with the sclera, being separated from the latter by a barrier of episcleral tissue only 1 mm. in thickness. The muscle seemed to be resting lightly on this tissue.

Eighth Postoperative Day: When this muscle was picked up with forceps it tore away from the sclera; no histologic specimens were obtained.

Tenth Postoperative Day: A section through the center of the attachment showed a dense band of well vascularized new fibrous connective tissue 2.1 mm. in length joining the muscle and the sclera. A few necrotic muscle fibers were

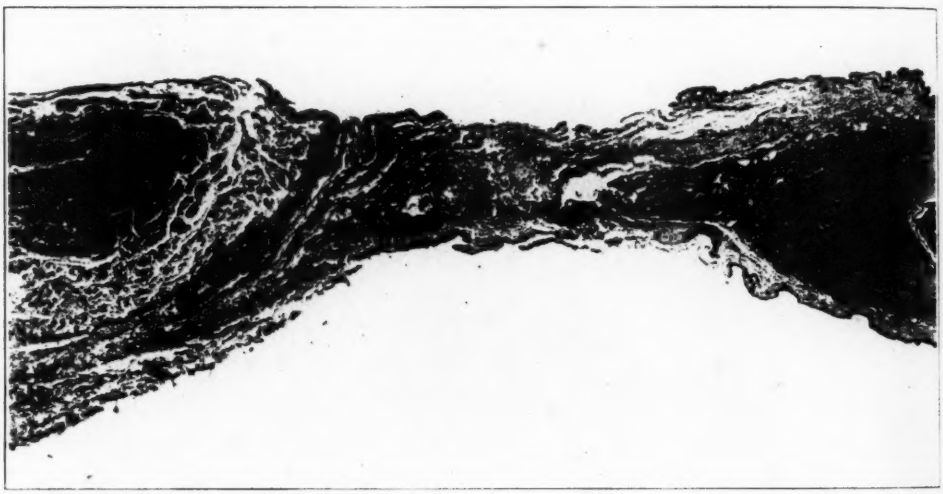

Fig. 2.—Simple tenotomy on the second postoperative day. The sclera is seen on the right, the muscle on the left, and between the two a loose meshwork; × 18.

interlaced between the young fibrous tissue. The blood vessels of the muscle close to the site of operation were markedly congested and surrounded by small round cells which were also present at the junction of muscle and fibrous tissue. At this point two processes, or better, two phases of the same process were taking place, i. e., first, degeneration of the terminal muscle fibers and phagocytosis of the necrotic material; second, invasion between the remaining muscle fibers by the rapidly proliferating connective tissue.

Twelfth Postoperative Day: The attachment was so lacking in strength that the trauma incident to cutting the histologic section had separated the muscle from the globe. Thin strands of new fibrous tissue had formed at the end of the cut muscle, but they did not extend as far as the sclera.

Fourteenth Postoperative Day: The process of organization was well advanced. A large amount of fibrous tissue had formed where the muscle had been transected, but in two histologic sections only a small number of these fibers reached as far as the sclera. Serial sections, however, might have demonstrated a place of firmer adherence.

Twenty-First Postoperative Day: The section demonstrated a normal muscle bound securely to the sclera by closely interwoven connective tissue fibers. The latter had penetrated for 0.5 mm. between the terminal muscle fibers—taken hold of them, as it were—and was attached over an area of the sclera 1.5 mm. in length.

Fortieth Postoperative Day: The muscle was so intimately united to the sclera that by casually looking at the section the muscle fibers seemed to run into the sclera. More careful examination, however, proved that fibrous tissue about 0.2 mm. in width joined the two structures.

In summary, it was found that following tenotomy there resulted a small hemorrhage consisting of fibrin and cellular elements. There was

Fig. 3.—Simple tenotomy on the fourteenth postoperative day. The muscle is not firmly connected to the sclera by the new fibrous connective tissue; × 28.

also an outpouring of a small amount of serum and polymorphonuclear, eosinophilic and round cells. The fibrin meshwork appeared to be the chief factor in attempting to reattach the cut muscle to the sclera during the first few days after operation. The fibrin also provided a latticework for the young fibroblasts. But sometimes the fibrin seemed merely to cause adherence of the muscle to loose episcleral tissue. Fibroblasts and capillaries appeared in large numbers about the fourth postoperative day. The injured terminal muscle fibers became necrotic and were removed by phagocytic cells. The fibroblasts in favorable cases had

formed by the tenth day a dense band of fibrous connective tissue between muscle and globe. The fibrous tissue probably then contracted because forty days after operation less than 1 mm. of granulation tissue could be seen.

Comment.—The microscopic observations correspond closely to what would have been expected from examination of the gross material. The possibility of misinterpretation may occur from failure to take a sufficient number of microscopic sections through various parts of the attachment; otherwise a point of strong union may be missed. The fallacy of applying in full without interpretation the results of animal experimentation to the human subject probably needs no emphasis; however, it seems that since failure of the muscle to attach to the eyeball following simple tenotomy in the human being is by no means unknown, plus the experimental observations here described, it is a reasonable conclusion that simple tenotomy is an uncertain procedure, fraught with a real and wholly unnecessary danger. This conclusion is borne out by the results of experiments which will be presently described in which firm union took place when the muscle was sutured to the globe.

ATTACHMENT WITH SUTURES

Next a study was made of the results following attachment of an extra-ocular muscle to the sclera by sutures. This technic is commonly carried out either in addition to tenotomy (i. e., in recession) or in advancements. The method used was to cut across the muscle at its insertion, remove a small portion and then attach the muscle by means of two sutures to another spot on the sclera. A small portion of the muscle was usually removed because the new attachment was farther back on the sclera than the original insertion and it was desired not to decrease the tension of the muscle. In case 3, a Worth advancement was employed. Sixteen attachments were performed, fine "A" silk being used twelve times, 000 chromic catgut twice and 000 plain catgut twice.

POSTMORTEM OBSERVATIONS

Gross.—In every case the muscle was firmly joined to the sclera.

Case 1.—Fourth Postoperative Day: The end of the muscle was approximated to the sclera by a compact network composed mainly of fibroblasts and capillaries. There was a small amount of hemorrhage as well as a cellular response. The cells were predominately polymorphonuclear and mononuclear of both the small and the large type, but there was also a scattering of eosinophilic and plasma cells. Fine shreds of fibrin were seen interlaced between all these elements. The fibroblasts had extended posteriorly between the muscle fibers for a distance of about 1 mm. The cytoplasm and nuclei of the muscle in this region were of the usual appearance. Penetrating one-half the thickness of the sclera was the silk suture and adjacent to it numerous epithelial cells (doubtless transferred there from the conjunctiva by inserting the suture at operation), mononuclear cells containing pigment (probably blood pigment) and fibroblasts.

CASES 2 AND 3.—Sixth Postoperative Day: A Worth advancement had been performed in case 3. The suture which had pierced the outer third of the sclera was surrounded by large numbers of fibroblasts. They appeared more prevalent than in the fourth day sections. In the dense mass of young granulation tissue could be seen isolated muscle fibers that were poorly stained and had lost their outline and striations. The cellular reaction was still evident.

CASES 4 AND 5.—Eighth Postoperative Day: The young fibrous connective tissue, now present in large amounts, stained well with the Mallory stain. A few disintegrating muscle fibers and round cells remained in the granulation tissue. Also prominent in this tissue were many small blood vessels the muscle walls of which appeared unusually thick.

CASES 6 AND 7.—Tenth Postoperative Day: The fibrous tissue was more dense. The disintegrating silk suture was penetrated by fibroblasts and mononuclear cells. In comparison with early sections there was a striking decrease in the cellular reaction and an equally impressive increase in the proliferative response.

CASES 8 AND 9.—Twelfth Postoperative Day: Case 9 showed an increased amount of connective tissue. In case 8, by mistake, I pierced the entire thickness

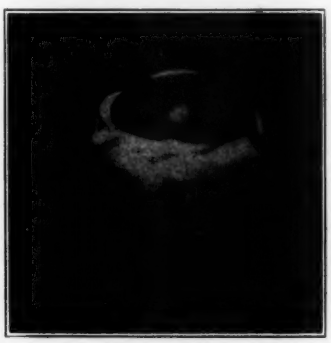

Fig. 4.—Attachment with plain 000 catgut on the twentieth postoperative day.

of the sclera with the suture needle. At this spot the outer coat of the eye was replaced by new fibrous tissue and the retina was held down by scar tissue. The trauma incurred in cutting the sections had detached the retina except in this region (fig. 5).

CASES 10 AND 11.—Fourteenth Postoperative Day: The muscle was adherent to the sclera by means of 1 mm. of dense fibrous connective tissue. Still remaining were small portions of suture material that showed evidence of disintegration.

CASES 12 AND 13.—Twentieth Postoperative Day: The attachment consisted of mature granulation tissue. Some of the muscle fibers reached to less than 1 mm. from the sclera. Many of these fibers showed evidence of atrophy. None of the plain catgut which had been used in this case was seen but there remained in one spot concentric circles of cells mainly mononuclear in type. Elsewhere in the organized tissue were a moderate number of eosinophilic, plasma and round cells, but the polymorphonuclear cells seemed to have disappeared by this time.

CASES 14 AND 15.—Thirtieth Postoperative Day: Some of the terminal fibers were in apposition with the sclera. The others were intimately united to it. No evidence was seen of the chromic catgut suture but there was present in one area the usual reaction to a foreign body, i. e., giant cells and mononuclear cells.

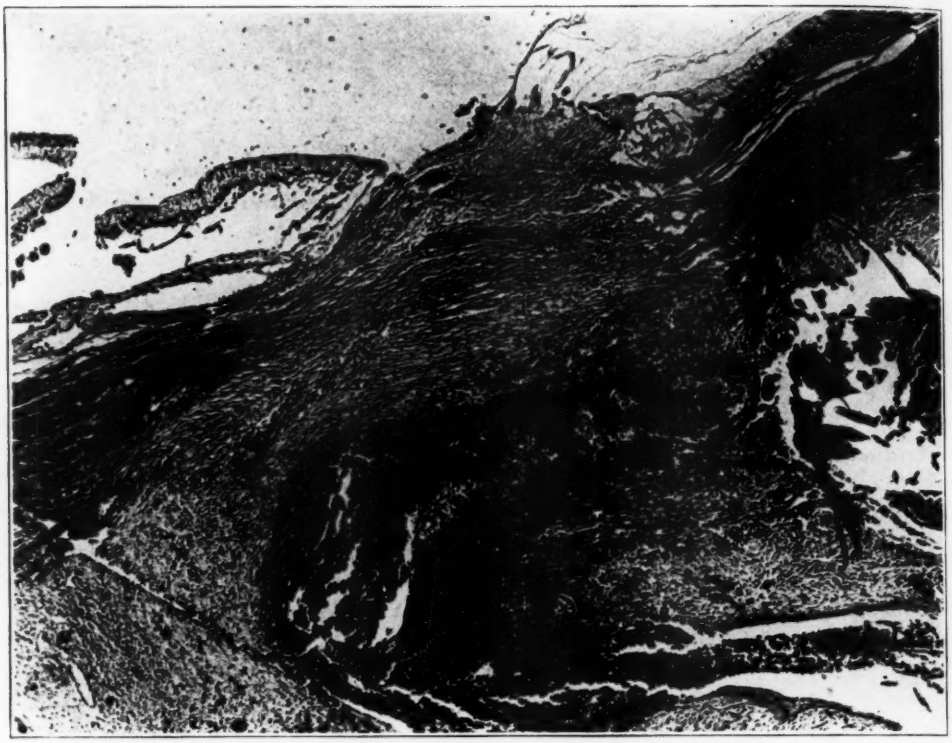

Fig. 5.—Attachment of the retina by scar tissue on the twelfth postoperative day. This is of interest in view of operations for detachment of the retina. The cellular reaction is due to the sutures; × 55.

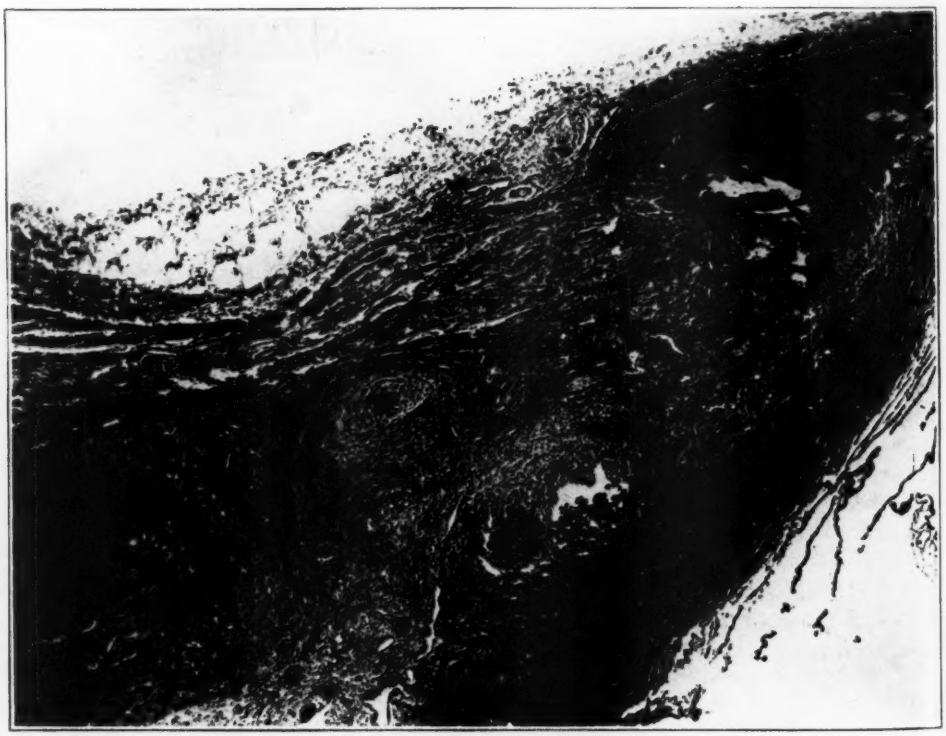

Fig. 6.—On the fourteenth postoperative day the muscle is seen to the left, the sclera to the right, and between the two strong fibrous connective tissue. Two silk sutures are shown in the outer third of the sclera; × 45.

CASE 16.—Fortieth Postoperative Day: The superior rectus had been inserted 9 mm. from the limbus with 000 plain catgut and a resection performed on the inferior rectus. Muscle fibers of the superior rectus were in direct contact with the sclera. The fibrous connective tissue forming this attachment extended 1 mm. posteriorly between the muscle fibers.

In brief, by the use of sutures the muscle is securely held against the sclera during the first few days after operation until organization has time to take place. The process of organization differs apparently in no respect from that occurring after injury to striated muscle elsewhere in the body. There is hemorrhage with the production of fibrin and a cellular reaction. The fibroblasts and capillaries appear in significant numbers on about the fourth day; the proliferative response gradually assumes more and more importance and the cellular reaction decreases in amount. A few muscle fibers traumatized at operation show evidence of disintegration and are probably phagocytosed. More muscle fibers crowded in between the granulation tissue undergo atrophy, but the muscle as a whole posterior to the region of insertion shows no changes; the nuclei and cytoplasm are clearly outlined, stain well and in every way look normal. The sutures, if catgut, are absorbed; if silk, they act as foreign bodies unless removed. The end-result is an attachment by dense fibrous connective tissue.

Comment.—A strong attachment resulted following all of the sixteen operations. Operations such as the Worth advancement or tenotomy plus reattachment with sutures (i. e., recession) appear to insure firm union. In the four cases in which catgut was used, the insertions were comparable to those in which silk had been employed. This is too small a series to be of value. Howes and Harvey have shown that the tensile strength of 000 plain catgut is completely lost in noninfected wounds on the third postoperative day. But at this time an insufficient amount of new connective tissue has formed to have any appreciable strength. Further, they find that in infected wounds chromic gut completely loses its strength from the fourth to the seventh day and conclude that "as skin cannot be sterilized completely even with the most elabroate technics, catgut sutures should not be used in it, passed through it, or come in contact with it in any way." Whether the possibility of infection from the organisms of the conjunctiva should forbid the employment of chromic gut is still, in our opinion, an open question worthy of further study.

TUCKING

In eight cases a tucking of an extra-ocular muscle was performed. The method employed was to place a tuck (with a Roberts' tucker) in the muscle from 3 to 5 mm. from its insertion, one double and two single silk sutures being used.

POSTMORTEM OBSERVATION

Gross.—The tuck in all instances was covered over with connective tissue. In order to obtain good sections this was not disturbed.

Microscopic.—Case 1.—Fourth Postoperative Day: The tuck consisted of muscle fibers, some of which were disintegrating, numerous young fibroblasts, a small amount of fibrin, red blood cells, polymorphonuclear cells and occasional small round cells, but the predominating cell was the fibroblast. Trauma to the muscle had caused a similar reaction from 2 to 3 mm. either side of the tuck.

Case 2.—Eighth Postoperative Day: The tuck consisted of muscle fibers interlaced among the compact young granulation tissue. Many of the muscle fibers showed evidence of atrophy. There was a dense cellular reaction consisting chiefly of mononuclear cells of both the small and large type, but also including occasional eosinophilic cells. Close to the sutures were single large cells containing many nuclei and penetrating the silk were numerous fibroblasts and round cells.

Case 3.—Tenth Postoperative Day: The muscle from its insertion posteriorly consisted of (1) 3 mm. of normal tissue, (2) then muscle fibers among new connective tissue, (3) the tuck of fibrous and muscle tissue, (4) muscle fibers among new connective tissue and (5) normal muscle.

Case 4.—Twelfth Postoperative Day: Compared with previous sections there was an increased amount of fibrous connective tissue in the tuck and a decreased number of muscle fibers. A bridge of granulation tissue lay between the muscle anterior to the tuck and that posterior to it. In this area of organization a cellular response was still present.

Case 5.—Fourteenth Postoperative Day: The histologic section demonstrated granulation tissue connecting not only both parts of the muscle to each other but also joining the muscle to the sclera in the region of the tuck. The Mallory stain confirmed the presence of fibrous connective tissue between the muscle and the sclera. In the photomicrograph of this section (fig. 7) pieces of silk suture are seen in the granulation tissue on either side of and just beneath the muscle fibers in the tuck.

Case 6.—Twenty-First Day: A marked cellular reaction had taken place around the suture material. A well organized granulation tissue had not formed to an extent which would have been expected from the preceding section. No muscle fibers were left between the sclera and the tuck.

Cases 7 and 8.—Twenty-Seventh Day: At the site of the tuck there remained granulation tissue and the silk sutures, which had not been removed. The muscle anterior to the tuck apparently had been replaced by strands of fibrous tissue. A dense mass of fibroblasts, mononuclear cells and giant cells surrounded the silk suture.

A study of the histologic sections would suggest that the repair after a tucking is somewhat as follows: At operation the parts of the muscle anterior and posterior to the tuck are approximated by the sutures. The trauma results not only in the production of a small amount of hemorrhage, a cellular infiltration, and probably some increase in the tissue fluids in this region but also in injury to the healthy connective tissue between the muscle fibers. With the fibrin network as support, the young fibroblasts and capillaries begin the organization of the tissue. The granulation tissue becomes more compact, and many of the muscle

fibers in the tuck show evidence of atrophy or disintegration. By the fourteenth postoperative day, a bridge of dense fibrous tissue had formed between the muscle anterior to the tuck and the muscle posterior to it (fig. 7).

Comment.—A few of the findings seem to warrant comment: 1. Figure 7 demonstrates that the new granulation tissue has caused the adherence of the muscle to the sclera in the region of the tuck. Therefore, the muscle after the formation of this adhesion, instead of pulling from its original site of insertion was pulling from a point 3 to 5 mm.

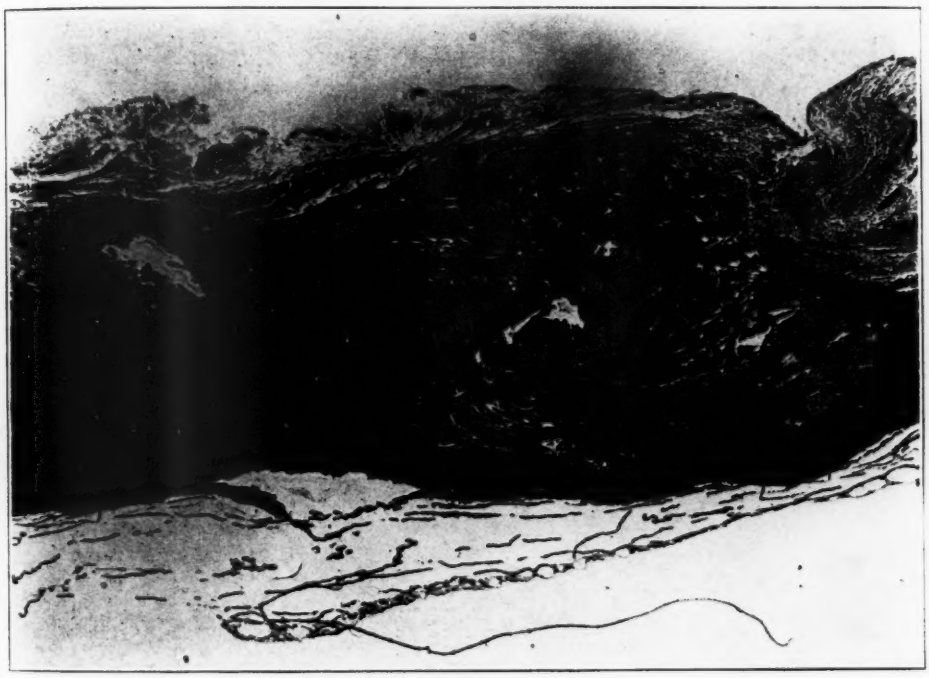

Fig. 7.—Tucking on the fourteenth day. The tuck is seen in the center and the muscle on either side of the tuck connected by fibrous connective tissue. Mallory stain for connective tissue; × 27.

posterior to that. 2. The presence of large numbers of polymorphonuclear and mononuclear cells in case 6 three weeks after operation is due either to infection or is a response to the disintegrating muscle fibers in the tuck. No culture was taken. It is doubtless somewhat dangerous to judge the strength of an attachment from the histologic section alone, but this muscle had so comparatively few strands of fibrous tissue connecting it to the sclera that it seemed likely the mass of cells had hindered the proliferative response and the connection was thereby weakened. This suggests the deleterious effect of infection on the process of repair.

3. It may be noted that in case 8 the silk sutures were purposely left in place although the animal was not killed until the twenty-seventh postoperative day. A typical foreign body reaction had occurred around the suture, and the muscle fibers anterior to the tuck were no longer present. The fibrous tissue, except that around the silk, was by no means as dense as expected and, at least in appearance, the attachment was less strong than usual. This possibly points to the undesirability of leaving a silk suture in an extra-ocular muscle after it has performed its original function.[2]

RESECTION

Twelve resections were performed and studied postoperatively. The method employed was essentially that described by Reese except that separate sutures were used in the conjunctiva because of its thinness in the rabbit.

POSTMORTEM OBSERVATIONS

Gross.—In all cases there was a strong union between the proximal and distal parts of the muscle (fig. 8*A*). At forty days only a slight ridge indicated the site of resection (fig. 8*B*).

CASES 1 AND 2.—Second Postoperative Day: The two parts of the muscle were approximated by sutures and numerous interlacing threads of fibrin (fig. 9). Few fibroblasts could be found. The small hemorrhage produced at operation extended a short distance either side of the resection. It should be noted that the fibrin clot also existed between the muscle and sclera. In case 2, a typical abscess 1.5 mm. in diameter had formed between the muscle fibers just anterior to the resection. The fibers of the muscle were widely separated by the mass of inflammatory cells. Polymorphonuclear cells in large numbers were present in the outer half of the sclera at this point and a scattering of cells reached to the insertion of the muscle.

CASE 3.—Fourth Postoperative Day: A considerable number of fibroblasts and capillaries filled the spaces between the muscle fibers. Some fibrin, red blood cells, polymorphonuclear and small round cells were also present.

CASES 4 AND 5.—Sixth Postoperative Day: Young vascularized connective tissue had formed a bridge between the ends of muscle and separated and apparently compressed the muscle fibers near the point of resection. Fibroblasts extended into the outermost part of the sclera in this region.

CASE 6.—Eighth Postoperative Day: New fibrous tissue bound the muscle to the sclera for a distance extending from a point 4 mm. distal to the resection even to the point of insertion. An abscess 1 mm. in diameter had formed at the site of resection and in this area only a small amount of granulation tissue could be seen.

CASE 7.—Tenth Postoperative Day: There was a localized exudative process surrounding the sutures at the point of resection and this zone was itself encircled by young fibrous tissue. Numerous necrotic muscle fibers were scattered among the dense mass of cells. The muscle was adherent to the sclera in this area.

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2. Dr. D. M. Gay, instructor in surgical pathology, and Dr. C. S. Burn, instructor in pathology, assisted in interpreting these sections.

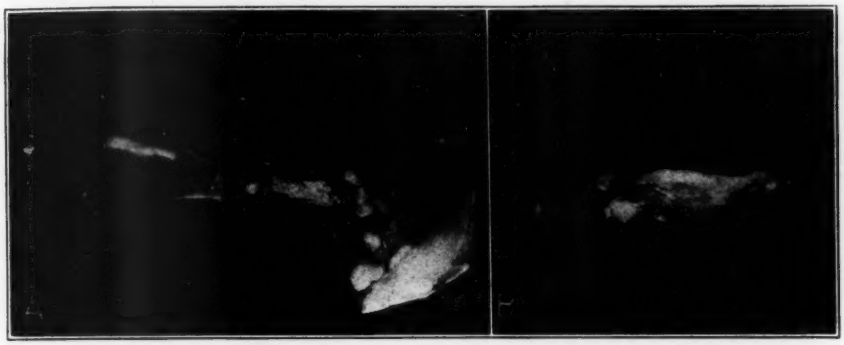

Fig. 8.—*A*, resection on the sixteenth day; *B*, extra-ocular muscle on which resection was performed forty days previously.

Fig. 9.—Resection on the second day after operation showing the sclera to the left, the distal portion of the muscle above and between the two a bridge of cellular elements and fibrin; × 125.

Case 8.—Twelfth Postoperative Day: Granulation tissue joined one part of the muscle to the other and both parts to the sclera. There was practically no cellular exudate. The newly formed connective tissue and the sclera took the same stain and at points graded almost imperceptibly into one another (fig. 10).

Case 9.—Sixteenth Postoperative Day: The organization had progressed so that a considerable amount of fibrous tissue was present, but many mononuclear cells could still be seen.

Fig. 10.—Resection on the twelfth day: *a*, the proximal portion of the muscle; *b*, the distal portion; *c*, fibrous tissue uniting one part of the muscle to the other but both at the sclera and *d*, the sclera. Mallory stain; × 125.

Case 10.—Eleventh Postoperative Day: The muscle fibers anterior to the resection had atrophied markedly and fibrous tissue extended between them as far as the original insertion of the muscle. Some of this fibrous tissue was also attached to the sclera for a short distance back of this point. The cellular reaction was less than in earlier sections.

Case 12.—Fortieth Postoperative Day: Dense fibrous tissue interwoven between the muscle fibers appeared to hold both parts of the muscle firmly together.

Comment.—Repair of the resected muscle as demonstrated by the histologic sections is much as would be expected. The sutures hold the two parts of the muscle together until fibrous tissue forms. The fibrin network produced at operation is prominent for from four to five days until the fibroblasts have proliferated in large numbers. There is always an exudative response. Numerous muscle fibers close to the site of resection undergo atrophy or necrosis. The localized cellular exudate (abscess) noted in three cases may be due to infection or may be in response to disintegrating muscle fibers. Either factor might give the same picture but since most of the sections did not show any such reaction, infection would seem to be a more probable cause. Since these areas, from 1 to 1.5 mm. in diameter, were not noticed in the gross, cultures were not taken. These cases then merely suggest the harmful influence of slight infections.

In several instances the trauma at operation resulted first in the formation of adhesions of fibrin between the muscle and the sclera both anterior and posterior to the point of resection and finally in the production of fibrous tissue so that the muscle was bound down to the globe for a distance of from 1 to 3 mm. back of the resection. Since the point of resection was from 3 to 4 mm. from the original insertion of the muscle it is clear that after operation in some cases the muscle was pulling from a point 4 to 7 mm. posterior to what was expected and desired.

CONCLUSION

It being impossible to study microscopically the repair following operation on the extra-ocular muscles of the human subject, the various operations in common use were carried out on rabbits. These animals were then killed at intervals of from two to forty days and gross and microscopic observations were made of the muscles and their attachments to the eyeball. Seventeen simple tenotomies, sixteen attachments with sutures, eight tuckings and twelve resections were performed. It was found that after simple tenotomy the muscle was sometimes firmly united to the sclera, but in other instances only loosely connected to it, even after from twelve to fourteen days. The reason for this appeared to be either that the muscle attached to loose episcleral tissue or that the blood clot formed at operation failed to hold the muscle firmly against the sclera during the first few days after operation until new connective tissue formed. In one case the muscle had entirely failed to attach and was discovered back of the globe. Since it is known that after simple tenotomy on the human eye the muscle has occasionally not attached to the sclera, this operation should be considered as a procedure that carries with it a wholly unnecessary danger which can be avoided by merely attaching the muscle to the sclera with sutures.

In the seventeen instances in which sutures, either plain, chromic or silk, were used the union was firm and after the tenth day strong fibrous tissue joined muscle to sclera. Chromic catgut was not employed frequently enough to obtain results of value, but its use is a subject worthy of further study. The process of repair following a tucking consists in the formation of new fibrous connective tissue between the proximal and distal parts of the muscle as well as the conversion of the tuck into fibrous tissue containing scattered muscle fibers. Likewise, the end-result after a Reese resection is the formation of a bridge of strong connective tissue uniting the two parts of the cut muscle.

One section through an eye on which an attachment with sutures was performed showed that the needle had by mistake pierced so deeply into the coats of the eye that retina, choroid and sclera were replaced by fibrous tissue; but it was interesting in view of current operations for detachment of the retina to find that the trauma incurred in cutting the sections had been sufficient to detach completely the retina everywhere except in the one region where injury had resulted in the formation of new fibrous connective tissue. Histologic sections demonstrated that immediately following any of the operations on the extra-ocular muscles a blood clot may exist between the muscle and sclera distal to the point of attachment and that later the clot may become organized so that the muscle is firmly bound to the sclera at some distance from the desired point of insertion. Photomicrographs are produced which show this process.

THE TODD MUSCLE TUCK WITH A MODIFICATION

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TECHNIC AS DEVELOPED AFTER TEN YEARS' EMPLOYMENT OF THE TUCKING OPERATION

Of the various operations at one's command in the practice of ophthalmic surgery, regardless of how highly developed they may be, I dare say none is associated more with an element of doubt as to the ultimate results than the operation on the muscles. As Hansell and Reber [1] have stated, "numerous operations for increasing the efficiency of any one muscle have been advocated. Their number points to the inadequacy of any single procedure."

Whenever a patient with squint consults an ophthalmic surgeon, the surgeon at once begins to conjecture as to just how much correction can be expected from an operative procedure. Shall one muscle be tenotomized? Would a better result be obtained by one of the shortening operations, or might not the ultimate effect be superior by use of a combination of these methods?

In manifest squints, it seems to be a question as to how much effect can be obtained and whether or not the effect will be lasting after the first week or so has passed. Many patients who have been operated on present a nice appearance of a slight overcorrection at the immediate completion of any of the advancement or shortening operations. Onlookers who see the bandage applied go away from the operating room with a glowing account of how well this or that operation has corrected a high degree of squint. They are possibly unmindful of the fact that much of the immediate effect of correction may be due simply to the drawing together of the conjunctival wound, which stretches out in a few days or perhaps a week and leaves nothing to encourage the operator that his ends have been attained.

If the correction of squint is dependent at all on any drawing together of a conjunctival wound at the completion of an operation, one must expect disappointment as to the end-result. It requires more than conjunctiva to hold an eyeball in place.

The resection operations have never appealed strongly to me, regardless of the end-results. Aside from the loss of a section of muscle,

1. Hansell, H. F., and Reber, Wendell: The Ocular Muscles: A Practical Handbook on the Muscular Anomalies of the Eye, Philadelphia, P. Blakiston's Son & Co., 1912.

there is the added danger of the stitches inserted in the sclera. I say sclera because it is my opinion that no stitch will hold a drawn-up muscle unless the sclera is split with the needle, and this is closely approaching the danger zone. Episcleral tissue, at best, presents a poor hold, and after a few days these episcleral stitches may usually be seen pulled out and some distance from their original insertion, with, of course, little correction.

It was due principally to these drawbacks that I sought an operation that would eliminate any resection of the muscle and at the same time demand no scleral stitching. The Todd tucking seemed to present these qualifications, and after ten years' use of this method with some modification, I prefer it to any other. This, of course, is a personal opinion. The tucking operation is safe. No muscular tissue is removed, and should anything unforeseen occur, the preoperative status is not impaired.

Contrary to the belief of some workers, this is not an operation practiced only by beginners. It may seem simple, but I have seen my interns give more time to studying the exact way to make the correct tuck than they have given to an apparently more complicated resection. Its simplicity seems to lead some who have tried the tuck with more or less unsuccessful results to overlook certain essentials which must be adhered to in order that the desired end may be obtained. If these measures are not strictly followed, the operation is condemned.

Of the tucker instruments to be had, I prefer the original Todd tucker with certain modifications. In the original tucker the prongs were made straight, making it difficult to pass them beneath the tendon in a deeply set eye. As a consequence I have modified this instrument by having the prongs come off at a right angle, and in addition have made one prong of sufficient thickness to allow a small notch in the center to facilitate the passage of the needle. With these modifications it will be found much easier to use this instrument.

The tucking operation as I am inclined to do it is started with an incision of possibly 5 or 6 mm. through the conjunctiva made with small, thin, blunt-pointed scissors. The incision is made parallel with and posterior to the limbus for about 6 mm. Grasping the conjunctiva with a good, secure bite of the fixation forceps, the cut is made. This is followed at once by inserting the closed blades of the scissors into the wound, where they are opened wide, thus stretching the wound and enlarging it to ample proportions. In fact, this first cut with the scissors is the only cut made during the operation. Following this, the scissors are used with closed blades and are not again opened. With closed scissors, complete exposure of the muscle can be easily made by pushing the conjunctiva and fascia away from all sides of the muscle and

tendon. No cutting is necessary for a complete and clean exposure of the tendon and muscle.

After free exposure of the tendon has been made, the latter is raised on the tenotomy hook and a saw-toothed, cup-shaped chalazion curet is used to clean off all fascia surrounding the tendon and muscle to be included in the tuck. Scraping backward from the insertion on top of the tendon and again beneath the tendon, all fascia is removed for approximately 15 mm.

This removal of the fascia acts in two ways. It gives better adhering surfaces and at the same time stirs up a certain amount of reaction which makes for tighter union during the process of repair.

After the baring of the tendon and adjacent muscle has been accomplished, the tucker is inserted with arms closed and crossed, it being seen that the overarm goes under the tendon and the underarm goes in advance of the tendinous insertion.

On the right externus, the tucker is held above the tendon with the operator at the patient's side. On the left externus, the instrument is held below the tendon with the operator back of the patient's head.

When the tucker arms have been engaged in the proper manner, the instrument is opened by turning the screw at the end. As the prongs separate, the muscle and tendon are drawn over the one arm and a tuck, measuring approximately from 6 to 8 mm., is secured. I do not believe that the muscle is shortened to this extent and think that there must be some stretching of the muscle to allow of this. Of course, the rotation of the eyeball toward the operative field would give an apparent increase in the shortening.

Following the spreading of the tucker arm, it becomes necessary to secure the tuck. This is accomplished by passing a curved needle carrying number 0 catgut, plain not chromicized, beneath the tucker arm and in contact with the sclera.

A word of caution is necessary here. Should forcible engagement of the needle be made to push it between the tucker arm and sclera, the latter could be easily punctured. To avoid this, rotate the instrument backward, thus relieving the pressure of the arm against the sclera, where, in fact, it has been indenting it, and raise it slightly away from the sclera. Now the needle can be easily placed in position, and by returning the tucker to its original position at the full height of the tuck, the needle slides through easily and without the slightest danger of puncturing the sclera. This is a point well worth remembering.

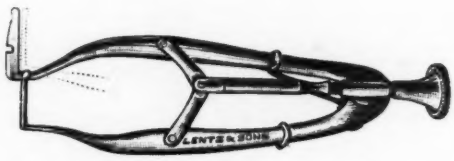
Todd placed his stitch external to the tucker arm and thereby lost about 4 mm. of tuck, which may be gained by inserting the needle as described. However, it is far more important that when tying the

catgut the tucker arm acts as a stop and prevents the knot from sliding on the tendon, thus still further preventing a diminishing effect of the amount of tuck obtained. This, with the curettement of the tendon, represents the modification of the original operation.

Having placed the stitch, the catgut is severed, freeing the needle, and the two halves of the tuck are tied off. Care must be exercised in tying off the tucked tendon. The catgut is drawn back of the tucker prong tip and tied securely.

One naturally thinks of strangulation, but I have never had it occur. Possibly, live tendon is more resisting than dead catgut, and it may be a survival of the fittest. I have never had a sloughing tuck. I have never had an untoward result from the standpoint of infection, pathologic changes or the like. The operation appears to be perfectly safe.

What shortening is to be secured is evident on completion of the tying of the catgut, and after removing the tucker, one may gain a good idea of the amount of correction obtained. Any further correc-



Instrument used for tucking.

tion secured by the finishing closing sutures may be ignored in the final result.

After removing the tucker, the wound is closed by two conjunctival sutures, including the conjunctiva and tuck. One suture is passed through the episcleral tissue near the limbus, thence through the loop of the tuck, finally coming out through the conjunctiva posterior to the wound. The remaining stitch is inserted in a like manner below, and the two are drawn together and tied, thus closing the wound.

Atropine is instilled in either eye for convergent squint and only in the eye operated on for divergent strabismus. An ointment consisting of mercuric chloride, 1 grain (0.065 Gm.), sodium chloride, 4 grains (0.26 Gm.), and petrolatum, 6 ounces (178 cc.) is applied, and both eyes are bandaged.

In convergent squint, the bandage is kept on for about ten days, being changed every day for cleansing purposes and the instillation of atropine. For the divergent type, the bandage is removed as soon as it is considered safe to do so, possibly on the third or fourth day. The reaction is moderate. Quite a bump is apparent for the first week or two, but this gradually subsides and eventually smooths out, allowing

the eye again to present a normal appearance or rather to exhibit no more scarring or disfigurement than after any other operation of advancement.

What happens to the tuck, one cannot say. Possibly an atrophy takes place. However, the fact remains that the eye regains a normal appearance after a few months.

In conjunction with the tuck, my opinion is that a careful tenotomy of the opposing muscle in high errors to secure a result pleasing to the patient must be done consistently, and after all, that is why the patient submitted to the operation.

By tenotomy, I do not mean a free slashing of everything in sight, as one sometimes sees done, but a guarded cutting of the tendinous attachment by means of small snips of the scissors opened for only a few millimeters through a small conjunctival opening and stopping at the very edge of the tendon—no farther. If the invagination of Tenon's capsule is not interfered with beyond the insertion margin, the danger of retraction is greatly minimized. If these "guy wires" are cut, anything may happen.

My procedure in tenotomy prohibits the use of the tenotomy hook. In sliding a tenotomy hook beneath a tendon much fascia is included as well as tendon, and when this is cut as it lies on the hook, the severed tendon has not much left to keep it from retracting later. Consequently, in place of the hook, small, single-toothed forceps are employed. With these the center of the tendon near its attachment to the sclera is grasped and a small buttonhole is made at this point. Now by slipping the tip of one scissors blade just within this opening and making small snips of approximately 2 mm., the tendon is gradually severed until the margin is reached. Then the remaining half of the tendon is severed in a like manner, it always being kept in mind that when the margin is reached the cutting must cease lest the aponeurosis be cut also. No suture is used.

A tenotomy done in this manner gives me about 3 or 4 degrees of correction several days after the operation, when done alone. I have not been able to register 10 degrees from a tenotomy as described. However, textbooks say that about 10 degrees may be expected from a tenotomy when done in the customary way, and my feeling in the matter is that this is due to careless cutting of fascial attachments gathered up on the tenotomy hook.

By doing a guarded tenotomy at the time of tucking, one operation supplements the other. To do the tucking or, in fact, any shortening operation and then to perform tenotomy a few weeks later is an admission of failure of the first operative procedure. The effect cannot then be secured unless a rather free tenotomy is done.

I fully realize that many would prefer a tuck on both eyes rather than a combination of the tuck and tenotomy. This, of course, rests with the individual operator.

In conclusion, I would again lay emphasis on the fact that I consider it of the utmost importance to bandage both eyes in convergent squint for at least from ten days to two weeks.

A NEW METHOD OF REGISTERING GRAPHICALLY THE OCULAR PULSE

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That an ocular pulse normally exists is clearly patent to all who have observed the rhythmic oscillations of the tonometer lever while the intra-ocular tension of an eye was being determined. Certain factors influence the amplitude of the lever's excursion. Parallel factors are to be found influencing the movements of the mercury manometer while the blood pressure of the brachial artery is being recorded. A consideration of the phenomena which occur in the brachial artery during this time will help to define these factors. If the pneumatic cuff is applied over the brachial artery and enough air pumped in to raise the pressure in the cuff above the systolic blood pressure, and, while the column of mercury in the manometric apparatus is being watched carefully, air is allowed to escape slowly, no motion of the mercury is seen at first, then suddenly there is a definite movement which corresponds in time to the cardiac beats. The point where the movement first appears denotes the arterial systolic pressure. As the air continues to escape from the cuff the oscillations of the mercury increase in height until at diastolic pressure they attain their maximum excursions. These movements of the mercury are dependent on changes in the air pressure within the cuff at each heart beat, the changes being in turn dependent on alterations in shape of the artery beneath the cuff. For example, assume that the blood pressure is 120 systolic and 80 diastolic. The shape of the artery under zero external pressure may be considered as a circle in cross-section (fig. 1 *A*). As the pressure within the cuff is raised above systolic (120), the vessel is in complete collapse, and no blood flows through (fig. 1 *B*). When the air is allowed to escape and the external pressure becomes just lower than 120, the blood at systole tends to force the vessel wall outward and slight displacements of air in the cuff occur. These are transmitted to the column of mercury as the first oscillations seen at systolic pressure. When the external pressure is decreased to 100 mm. of mercury, for example, the excursion of the vessel wall is as seen in figure 1 *C* from *a* to *a'*. During diastole the external pressure is sufficient to overcome a force of 80 mm. of mercury but it can only partly flatten out the artery when the pressure within its lumen rises to

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120 mm. As the air is further released, when 80 mm. external pressure is reached, the vessel walls attain their greatest displacement, for the blood still cannot force open the vessel during diastole, while with the decreased outside pressure the vessel wall can be pushed back to practically its normal position by the internal force of 120 mm. of mercury during systole, and the movement is obviously larger (fig. 1 *D*). If the cuff is still further depleted of air the original state in figure 1 *A* is approached.

If one were to dissect out and lay bare a small artery no considerable pulsation would be detected with the eye. One can understand why on inspection a pulsation of the eyeball cannot be detected: The tunics of the eye have lost much of their potential elasticity because they are under constant tension due to the intra-ocular pressure. Moreover, the slight pulsatory force is to the observer further minified by being distributed over the entire surface of the globe. Applying the same conditions to the eye as to the brachial artery, one

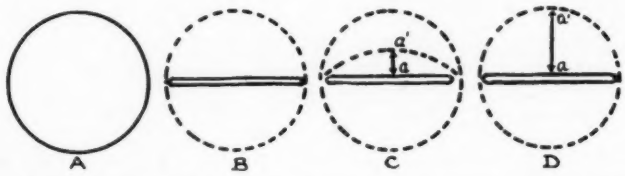

Fig. 1.—Diagrams showing the excursions of the vessel walls during the act of blood pressure determination.

will realize that by adding just the right amount of pressure on the outside a point can be arrived at where the external pressure plus the intra-ocular pressure of the humors will exactly balance the diastolic pressure within the large ocular vessels and here the maximum excursions of their walls obtain. These movements are then imparted to the ocular tunics, and if the tonometer with its weight acts as the source of external pressure the movements of the tonometer lever will be seen at their best when diastolic pressure is reached. For practical purposes the standard tonometer weights with a few intermediary ones afford sufficiently variable forces to find a close approach to diastolic pressure; one simply tries one weight after another and selects the one which brings out the best movement of the lever. More or less than the optimum weight will decrease the amplitude of the movement. The pulsations of the retrobulbar vessels play a negligible rôle in the production of the ocular pulse. The degree of rigidity of the ocular coats assumes an important part in determining the size of the ocular pulsations. This is sometimes evident in cases of keratoconus, when the cornea is quite yielding and even spontaneous pulsations of the cornea may be seen.

Bearing these facts in mind, I began in 1928 an attempt to translate the ocular pulsations into a graphic image, and after a number of unsuccessful methods were discarded the following procedure was evolved. The principle is to obtain a motion picture of the movement of the tonometer lever and then to project the individual photographs serially on a screen, measuring the amount of movement in each frame and plotting the findings as a curve. A special scale was mounted above the regular scale of the Schiötz tonometer, and a fine sewing needle which had been given a gun-metal appearance by holding it in a flame was fastened to the tonometer lever (fig. 2). The movements of the needle against the scale were photographed at a distance of about 3½ feet. A stock motion picture camera was employed, the film

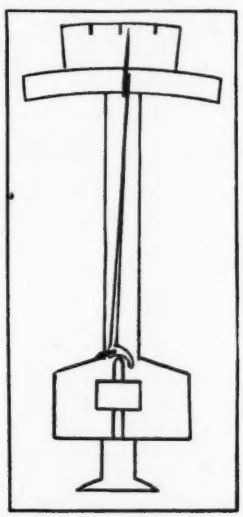

Fig. 2.—Tonometer with special scale and needle extension.

running past at slow motion speed—64 frames per second. For sharp focusing a critical focuser mounted on a revolving turret was used; when the scale was sharply visible through the focuser a 4 inch lens was swung into place and the exposures made. The developed film was then thrown on a screen by means of a carbon arc projection microscope, one frame at a time. The distance of the needle tip from the nearest line was measured accurately with a vernier calipers. These measurements were plotted as seen in figures 3 and 4.

In the interpretation of the pulsation curves it is well to exercise considerable restraint. This much is evident: Curves similar to the ordinary pulsation curve of the carotid artery, even to the secondary undulations, may be obtained. Is there any information to be derived from these curves which one cannot gather more easily from the usual tracings of the radial and carotid pulsations? Obviously, the only

reason for studying the ocular pulsations would be to seek some index to the local vascular state or possibly to the intracranial circulation. Wegner,[1] by means of a pneumatic plethysmograph, has obtained some excellent tracings of the ocular pulse. He has concluded that in arterio-

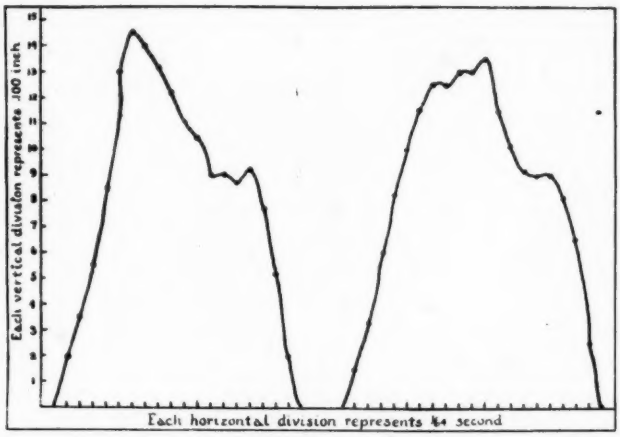

Fig. 3.—Normal right eye; tracings made five minutes apart from the same patient. Note the differences in the curves.

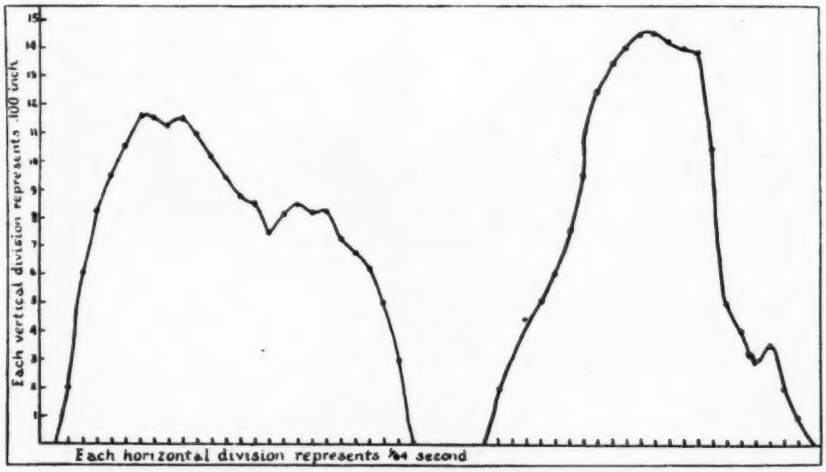

Fig. 4.—Normal eyes; tracings made on different patients.

sclerosis a higher and more pointed pulse curve is produced (modified in a later publication[2]), whereas in glaucoma the rise of the curve is

1. Wegner, W.: Klin. Wchnschr. **7**:2290 (Nov. 25) 1928; Arch. f. Augenh. **102**:1 (Dec.) 1929; ibid. **103**:296 and 303 (June) 1930.

2. Wegner, W., and Lämmerhirt, F. G.: Ztschr. f. Augenh. **75**:317 (Nov.) 1931.

lower and less sharp than in the normal. One must remember that arterial tracings in general are often inconstant and subject to individual variations from time to time. This may be readily appreciated from figure 5.

Of course, these are variations which occur under controllable conditions, but they serve to show how labile the cardiovascular system may be to other stimuli, such as fright, discomfort or pressure on the eyeball. Not all persons need respond in the same manner. An additional uncontrollable factor in the character of the ocular pulse curve is the rigidity of the ocular coats; this factor may be extremely variable, as those who have attempted digital estimation of the intra-ocular tension must know, and the degree of rigidity may often be inconsistent with the age of the patient and may be independent of sclerosis of the other tissues of the body. Wegner's apparatus has the added advantage of

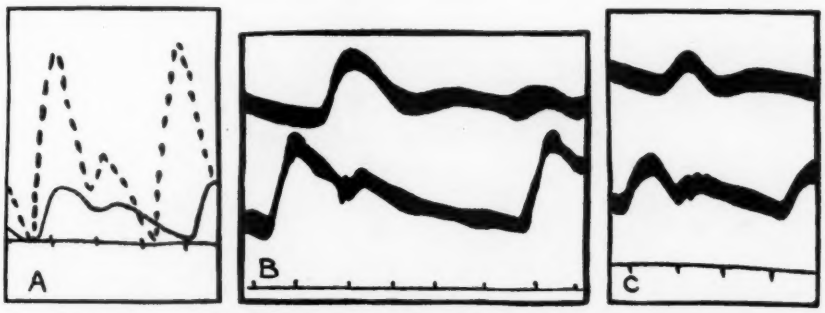

Fig. 5.—*A*, tracings of photographic records of brachial pulse of normal subject at rest and immediately after exercise (after Norris, Bazett and McMillan); *B*, lower curve, tracing of pulsation of carotid artery; upper, pulsation of dorsalis pedis artery of subject lying horizontally; *C*, lower curve, tracing of pulsation of carotid artery; upper, pulsation of dorsalis pedis of patient in *B* in a vertical position (*B* and *C* after Rengvist, from Norris, Bazett and McMillan).

lending itself to the quantitative determination of the systolic and diastolic intra-ocular blood pressures. The method which I have used is rather tedious, but it offers a minimum of discomfort to the patient and entails the use of standard apparatus which is obtainable with comparative ease in most hospitals. I present it chiefly as a method, novel, so far as I know, for the analysis of small amounts of motion when it may be undesirable to apply long levers and weighty mechanism on the subject; indeed, when the motion is sufficient, a graphic analysis may be obtained without intermediary leverage. I believe that this idea might be employed in reducing to graphic forms muscular tremors, nystagmus and similar normal and abnormal movements.

Ophthalmologic Review

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PHYSIOPATHOLOGY OF THE VOLUNTARY AND REFLEX INNERVATION OF OCULAR MOVEMENTS

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The movements of the eyes produced by voluntary or reflex impulses (mainly labyrinthine and retinal, but also partly cochlear impulses) are, as a rule, associated movements, both eyes moving in the same direction. It must be remembered that cortical localization is concerned with ocular movements, not with single muscles as are the nuclei of the ocular muscles, stimulation of the cortex producing, like the voluntary impulse, movements of both eyes in the same direction (conjugate deviation of both eyes). Such conjugate movements of the eyes may be produced experimentally by stimulation of three areas, namely, the frontal lobe, the occipital lobe (especially the gyrus angularis, found on the border between the parietal and the occipital lobe) and the temporal lobe. By stimulation of the frontal center (prerolandic area, Fritsch and Hitzig, Ferrier, Mott and Schaefer), one causes, not only horizontal movements of both eyes to the opposite side, combined with movements of the head in the same direction, but also vertical movements and movements of convergence, elevation of the upper lids and dilatation of the pupils. When one stimulates the occipital lobe, one usually needs stronger currents to produce movements of the eyes than in the stimulation of the prerolandic area. As a rule, one again observes conjugate deviation of the eyes to the opposite side; sometimes, also, vertical or convergent movements and dilatation of the pupil may be observed (Luciani and Tamburini, Ferrier, Schaefer, Minkowski). These effects not only are due to stimulation of the gyrus angularis but may be produced by the stimulation of a rather large area on the lateral surface of the occipital lobe.

From the Department of Experimental Neurology, D. J. McCarthy Foundation, Temple University School of Medicine.

and even from its medial surface. They can be observed even though the center in the frontal lobe has been removed (Schaefer). Especially have Bárány and C. and O. Vogt shown the differences between the effects of stimulation of the frontal and of the occipital lobe. They observed, by stimulating the frontal lobe, faster movements of the eyes than when the occipital lobe was stimulated, and found that the nystagmus produced by the stimulation of the labyrinth with cold water was influenced differently from these two areas. The movements of the eye observed after stimulation of the temporal lobe (gyrus temporalis superior) are also usually directed toward the opposite side, and are often accompanied by movements of the opposite ear (Ferrier). In man, particularly, Foerster produced movements of the eyes to the opposite side by stimulation of the gyrus frontalis medius, combined with movements of the head by stimulation of the gyrus frontalis superior, and photopsia and optic hallucinations by stimulation of the lateral surface of the occipital lobe.

The cortical centers concerned with ocular movements seem to have different functions. In the frontal area, there seem to arise the impulses for voluntary movements of the eyes, whereas the occipital center seems to have to do with reflex movements of the eyes following optic impulses, and the temporal center with reflex movements of the eyes produced by acoustic stimuli.

The cortical centers of both sides are, as far as the horizontal movements of the eyes are concerned, antagonists, as the impulses starting from each hemisphere try to move both eyes to the opposite side. Even if these centers are resting, they seem to send continuous impulses to the periphery. One can observe that the one-sided destruction of the frontal center or of its corticofugal fibers has, at least for some days, an effect similar to that of stimulation of the opposite side, namely, a conjugate deviation of both eyes and, eventually, also of the head (Prévost) toward the lesion. This is because the influence of the antagonistic contralateral cortex is no longer balanced. In diseases in which increasing pressure acts on the frontal lobe on one side, for instance in the case of extradural hemorrhage above the frontal lobe (rupture of the middle meningeal artery), one can observe the succession of symptoms due to stimulation and then those due to paralysis: first, deviation of both eyes and eventually deviation of the head to the opposite side, and later a conjugate deviation to the side of the injury, which lasts for some time. The paralysis of the ocular movements to the opposite side, which is, as a rule, associated with the conjugate deviation toward the side of the cortical injury, also improves after some time (compare the experiments of Levinsohn on monkeys). The patient then has difficulty only in bringing the eyes to an extreme position on the side opposite the injury. Nystagmoid movements of

the eyes may appear, if such extreme movements of the eyes to the opposite side are innervated by the patient. After lesions of the occipital lobe or of the gyrus angularis, the conjugate deviation to the side of the injury is usually observed only if the lesion reaches the subcortical fibers, especially the corticofugal fibers that join the optic radiation (see later). Although in some cases, difficulty in moving the eyes toward the side of the hemianopia has been observed in injuries of the occipital lobe (Best), disturbances of the cortical retinal reflexes on the movements of the eye, as shown by the loss of the fast component of the optokinetic nystagmus toward the side of the hemianopia (see page 745), are much more pronounced. It is rare that cerebral diseases cause a permanent difficulty in moving both eyes voluntarily, as may be observed in cases of pseudobulbar paralysis (bilateral injuries of the internal capsule). In these cases of pseudo-ophthalmoplegia (Wernicke) some reflex stimuli, for instance acoustic stimuli, are still able to produce movements of the eyes.

The centrifugal pathways from the frontal lobe enter the internal capsule; the corticofugal fibers from the occipital lobe, especially those from the optomotor area around the area striata, seem to join the optic radiation. A large number of these fibers from the occipital lobe seem to take their course below the gyrus angularis and are easily accessible for stimulation or injury of this area. This explains the conjugate deviation observed in diseases of this focus. The corticofugal fibers are further found in the lateral wall of the posterior and of the inferior horn of the ventricle on the inner side of the corticopetal optic fibers (stratum sagittale internum), with Gratiolet's optic radiation. They are later found in the posterior part of the internal capsule and end partly in the pulvinar, partly in the roof of the corpus quadrigeminum anterius and partly in the lateral geniculate body (Probst, Minkowski). It is not yet clear how much these ganglions have to do with the transmission of the impulses to the ocular muscles. The corpora quadrigemina are not necessary for this transmission (Bernheimer, Niessl von Mayendorf), nor is the posterior commissure necessary (Ken Taga). In the brain stem, the fibers from the frontal lobe and also some fibers from the occipital lobe (Hoesel) are found in the pedunculus cerebri (see Spiller). It holds true for these tracts as for the cortex that stimulation, such as that by a hemorrhage or tumor in the neighboring corpus striatum, produces deviation toward the opposite side,[1] and that an injury

1. Muskens has shown that the nucleus commissurae posterioris, which sends descending fibers in the posterior longitudinal bundle, is connected with the globus pallidus. One might suppose that a stimulation or injury of the basal ganglions could produce a deviation of the eyes by impulses conducted along these systems to the ocular muscles, but this question needs further investigation. In any case, the commissura posterior is not necessary to produce conjugate deviation of the eyes by stimulation of the frontal lobe (experiments of my co-worker, Ken Taga).

produces conjugate deviation of both eyes to the same side. The place where these tracts cross the midline is supposed to be in the midbrain or in the cranial part of the pons (Marburg).

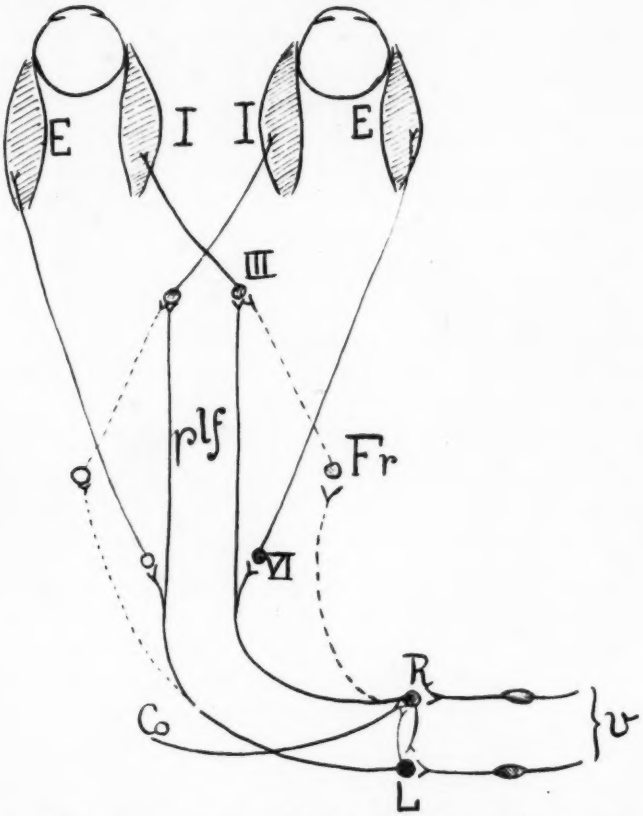
In the rhombencephalon, the pathway for the voluntary impulses seems to be common with that for the vestibular reflexes to the eyes; in other words, it seems that the cortical impulses use the way of the vestibular reflexes to reach the ocular muscles. One generally explains (see Spitzer, Muskens) the paralysis of gaze caused by pontile lesions in the neighborhood of the nucleus of the sixth nerve (first observed by Foville) by the destruction of the fasciculus longitudinalis posterior. As a rule, a lesion of this bundle on one side produces a paralysis of gaze to this side, and a conjugate deviation to the opposite side, which is much more chronic than after a cortical lesion.[2] The head can be deviated to the side of the injury or to the opposite side (see Bielschowsky). To produce conjugate movements of the eyes by stimulation of the frontal lobe, it is more important that the posterior longitudinal bundle be intact than when one produces a deviation of the eyes by labyrinthine stimulation (Spiegel and Tokay). The effects of the loss of this bundle last longer and are less compensated in regard to the first function than in regard to the second.

How do the corticofugal impulses to the ocular muscles enter the fasciculus longitudinalis posterior? It seems that the impulses from the frontal lobe are transmitted to this bundle by the neurons of the vestibular nuclei; in other words, it seems that the fibers from the vestibular nuclei, which are found in the fasciculus longitudinalis posterior, carry to the ocular muscle nuclei labyrinthine impulses as well as cortical impulses, as far as horizontal movements of the eyes are concerned. Teschler and I destroyed the vestibular nuclei on both sides and compared the effects of the stimulation of the ocular center in the frontal lobe before and after the injury. It was found that the lesion of the vestibular nuclei changed the effect of the stimulation; instead of the normal, usually horizontal, deviation of the eyes to the opposite side, there were vertical movements. Sometimes, if only a part of the vestibular nuclei had been injured, horizontal or rotary movement to the side of the stimulation was observed. These experiments suggest that the cortical impulses, especially those for horizontal movement of the eyes, before entering the fasciculus longitudinalis posterior, have a relay station in the neurons of the vestibular nuclei.

These experiments give an understanding of how the law of reciprocal inhibition of antagonists is effective, if one stimulates the cortical

2. The conjugate deviation of the head and the eyes observed in cases of cerebellar abscess (Meyers) is probably due to pressure on the posterior longitudinal bundle.

centers of the ocular muscles. Sherrington found that stimulation of the cortical center in the frontal lobe, for instance that of the left side, is followed not only by a contraction of the muscles that move the eyes to the right side (right external rectus and left internal rectus), but also by a relaxation of the muscles that move the eyes to the left side (left external rectus and right internal rectus). This is clearly shown by the fact that, even after a paralysis of the muscles that move



Reflex inhibition of ocular muscles. *Co*, cortical impulse; *E*, external rectus; *Fr*, formatio reticularis; *I*, internal rectus; *L*, cells of the vestibular nuclei, sending impulses into the left posterior longitudinal fasciculus (*plf*); *R*, cells of the vestibular nuclei, sending impulses into the right posterior longitudinal fasciculus; *V*, vestibular; *III*, nucleus of third nerve; *VI*, nucleus of sixth nerve.

the eyes to the right, stimulation of the corresponding cortical areas is still able to produce a movement of the eyes to the right side, at least to the midline. As each fasciculus longitudinalis posterior carries impulses for a conjugate movement of both eyes to its own side, stimulation of the frontal lobe on the left side is followed by excitation of the right posterior longitudinal bundle as well as by an inhibition of the left fasciculus longitudinalis posterior. The explanation for this

is furnished by the experiments already referred to, which show that the cortical impulses for ocular movements have a relay station in the vestibular nuclei before they enter the fasciculus longitudinalis posterior. As it is known that the vestibular nuclei send fibers in the posterior longitudinal bundle of the same and of the opposite sides (see later), one might suppose that the cortical impulse uses the same mechanism after reaching the vestibular nuclei as does the labyrinthine impulse.

The experiments on spinal cord reflexes, in the last few years, have led to the following ideas as to the origin of reflex inhibition (Verworn, Froehlich, Lucas, Bruecke, Adrian): The impulse seems to be so far lowered in intensity on its way to the cell group the action of which is to be inhibited that it is no longer able to reach these cells, but it leaves a refractory period behind itself and, in this way, stops such impulses as usually stimulate this group of cells. Let me use these ideas to explain the reflex inhibition of the ocular muscles, and let me call the cells of the vestibular nuclei that send fibers into the left posterior longitudinal bundle "L-cells" and those sending fibers into the right bundle "R-cells" (see diagram). A labyrinthine impulse producing deviation of the eyes to the right side will reach the R-cells in its full strength, but before reaching the L-cells it will be lowered in intensity (for instance, by increased resistance in the respective collaterals). The impulses that are conducted in the left posterior longitudinal bundle are not able to travel through the synapse that is around the centers of the left external rectus and the right internal rectus, but they leave in the pathways where they have traveled a refractory period, and thus they block these nuclei from such impulses as normally excite them. This mechanism is shown in the diagram. A fiber coming from the labyrinth and producing a deviation of both eyes toward the right side stimulates the R-cells of the vestibular nuclei. To reach the L-cells, the impulse has to use a collateral of the R-cell; in this way, the impulse becomes weakened. A deviation of the eyes toward both sides can be produced by stimulation of each labyrinth (for instance, by hot or cold water). One must therefore assume that, on each side, the R-cells as well as the L-cells can be reached by normal and lowered impulses.

The experiments of Teschler and myself have shown the importance of the vestibular nuclei for the genesis of conjugate horizontal deviation of the eyes after stimulation of the frontal lobe. One might therefore assume that the mechanism just described is also used by the cortical impulses. Such impulses from the left cortex, for instance, might reach the R-cells of the right vestibular nuclei. From here, the exciting impulses are conducted into the right posterior longitudinal bundle, and lowered impulses, which have an inhibitory effect, are conducted into the left fasciculus; in this way the muscles that move both

eyes to the right side are stimulated and the antagonists are inhibited. It is still uncertain whether the cortical pathway for the innervation of ocular movements takes a direct way from the cortex to the vestibular nuclei, or whether this pathway is interrupted in some subcortical ganglions. One finds in the literature many theories conjecturing a gaze center in the thalamus (A. Spitzer), in the corpora quadrigemina (Adamük), in the region of the sixth nucleus (Wernicke) and in the formatio reticularis (von Monakow, Bárány), but none of these theories is proved.

The cortical innervation of vertical movements of the eyes is less known that that of horizontal movement. The aforementioned experiments have shown that, after destruction of the vestibular nuclei, the stimulation of the cortex can produce vertical movements of the eyes instead of horizontal movements. One might conclude that vertical movements of the eyes might be partly innervated without the help of the vestibular nuclei or of the posterior longitudinal bundle, but it is quite possible that some part of the vestibular nuclei is intercalated in a part of the cortical pathway for vertical movements of the eyes. Poetzl and Sittig have shown that the skew deviation of Hertwig and Magendie (the eye on the side of the injury deviated downward and inside, and the eye of the opposite side deviated upward and outside) may be observed if the ventrocaudal part of Deiters' nucleus or the descending root of the vestibular nerve is injured. Marburg has supposed that the impulses for upward movement of the eyes are conducted by the left posterior longitudinal bundle and the downward movements by the right bundle, but further studies seem necessary to answer all these questions. Scala and I stimulated the posterior longitudinal fasciculus in cats, but were unable to find a relation of a certain side to upward or downward movements.

It has been mentioned that the center in the frontal lobe has to do with voluntary movements of the eyes, and that the center in the occipital lobe is important for the reflex movements of the eyes that are induced by retinal impulses. The importance of the centrifugal pathways, starting in the occipital lobe, for such reflex movements of the eyes is shown by the analysis of the optomotor (optokinetic) nystagmus (Bárány, Brunner, Ohms, Lebensohn). If a patient sits before a drum or in its center and looks on vertical black and white lines on this drum, which is slowly rotated before his eyes, one can observe a slow movement of the eyes in the direction of the rotation of the drum. This slow movement is followed by a fast movement in the opposite direction; this is the result of an optic reflex that tends to move the eyes toward the new lines entering the visual field. Such slow and fast movements, constituting optomotor nystagmus, follow each other as long as the drum is rotated in front of the patient, and

as long as he holds his attention on the lines. The fast movement is the fast component of this optomotor nystagmus; in other words, the direction of this nystagmus is opposite the movement of the drum.

We have here to do with an optic reflex the centripetal pathway of which is furnished by the corticopetal optic fibers. In cases of homonymous hemianopia, this optomotor nystagmus often cannot be produced with its fast component to the side of the hemianopia (Bárány, Wirths). Bárány and others (Kestenbaum) explain this by the loss of the centripetal impulses from the blind half of the visual field, but Cords observed cases of injury of the optic tract in which the hemianopia had no influence on the optokinetic nystagmus. On the other hand, in those cases in which Gratiolet's optic radiation, or a large part of the occipital lobe, including the optomotor area of the lateral surface, was injured, the optokinetic nystagmus could not be produced toward the side of the hemianopia (see also Wernoe, Stenvers). One must conclude with Cords that, contrary to the opinion of Bartels, the optokinetic nystagmus is, at least in man, a cortical reflex, and that the loss of the optokinetic nystagmus in these cases of hemianopia is due to the injury not of the centripetal part of the reflex arc but of the centrifugal fibers which start in the lateral surface of the occipital lobe and run on the inner side of the corticopetal fibers within the Gratiolet's radiation.

To follow the further centrifugal pathways of this reflex, I (unpublished experiments) stimulated the lateral surface of the occipital lobe in dogs and cats, and studied the effect of this stimulation on ocular movements before and after injury of the vestibular nuclei. Normally, by stimulation of this area, one can produce conjugate movements of both eyes, usually to the opposite side, sometimes combined with a vertical component; also, vertical movements alone may be observed. After bilateral injury of the vestibular nuclei, the effect of this stimulation was changed; it was no longer possible to produce the conjugate deviation to the opposite side, whereas the vertical movements of the eyes could still be observed. One might conclude that, as far as horizontal movements of the eyes are concerned, fibers from the vestibular nuclei into the fasciculus longitudinalis posterior are the final common path for the impulses from the occipital lobe (for optic reflexes on the eyes) as well as for the impulses from the frontal lobe (for voluntary movements of the eyes) and for the labyrinthine reflexes of the eye.[3]

To understand the influence of all these impulses on the eyes, it seems necessary to study, in more detail, the relation of the vestibular

3. Ohm (Arch. f. Ophth. **126**:221, 1931) observed that a nystagmus produced by rotation can be different in the dark and in the light; he supposed that optic impulses enter Deiters' nucleus but without proving his hypothesis.

nuclei to the innervation of the ocular muscles. The simplest way for such a study is the stimulation of the vestibular nuclei from the peripheral receptor, from the labyrinth. It is a well known experience that a slight rotation of the head, to the right side, for instance, produces a conjugate deviation of both eyes in the opposite direction (this slow deviation corresponds to the slow component of the nystagmus). A strong stimulation of the labyrinth (like rotation on the Bárány chair or stimulation with cold or hot water or the galvanic current) produces, instead of the slow deviation, a rhythmic reaction, the nystagmus, the fast component of which is a rhythmic interruption of the slow deviation.

To begin with the mechanism of the slow component, the generally accepted explanation of the conjugate deviation of both eyes is the following: The fasciculus longitudinalis posterior of the left side, for instance, carries vestibular impulses to the left sixth and third nuclei, innervating the left external rectus by the fibers of the nervus abducens, and the right internal rectus by crossing fibers of the oculomotor nerve. Recently, Klossowsky and Levikowa tried to show that the fibers of the oculomotor nerve, innervating the internal rectus for conjugate deviation of the eyes, do not cross the midline. These investigators cut the fasciculus longitudinalis posterior on one side between the sixth and the fourth nuclei and combined this operation with the extirpation of the musculi recti externi and of the external bundle of the musculus retractor bulbi. They stated that, after such an operation, rotation no longer produces a nystagmus of the eye on the side of the injured fasciculus longitudinalis posterior. This would mean that the fasciculus longitudinalis posterior carries only the impulses to the internal rectus on its own side; but, in many of these experiments the investigators were unable to produce a nystagmus on both sides, which is not explained by this theory. Furthermore, Scala and I [4] were able to observe that the localized stimulation of the fasciculus longitudinalis posterior of one side in the cranial part of the pons produced a movement of the opposite eye toward the side of the stimulation. It seems, therefore, unnecessary to abandon the ideas that the fasciculus longitudinalis posterior carries, in the cranial part of the pons, the impulses to the internal rectus of the other side, and that the impulses for the conjugate deviation of the eyes use the crossing fibers of the oculomotor nucleus to the internal rectus.

One can produce from each labyrinth a conjugate deviation of the eyes (for instance, to the left side) by stimulating, during narcosis, which abolishes the fast component of nystagmus, the left labyrinth with cold water or the right labyrinth with warm water. This is easily understood by reason of the fact that each posterior longitudinal bundle

4. Spiegel, E. A., and Scala, N.: Unpublished experiments.

carries fibers from the vestibular nuclei of the same side as well as from those of the opposite side. In the example mentioned, the fibers of the left fasciculus longitudinalis posterior from the left vestibular nuclei will be stimulated following the irrigation with cold water, and the crossed fibers from the right vestibular nuclei into the left fasciculus longitudinalis posterior will be stimulated following the irrigation with warm water.

The mechanism of the conjugate deviation is complicated by the law of reciprocal inhibition of antagonists, as has been shown for the vestibular nystagmus by Bartels and de Kleyn. One can produce a deviation of the eyes to the left side, to some extent at least, by a stimulation of the labyrinth, even if the left external rectus or the right internal rectus is paralyzed. This is due to the fact that the reflex impulse that stimulates the muscles moving the eyes to the left side inhibits at the same time the antagonistic muscles that tend to move the eyes toward the right side. As each fasciculus longitudinalis posterior carries the impulses for a conjugate deviation of both eyes to its own side, one has to assume that the conjugate deviation of the eyes to the left side is innervated in such a way that the left fasciculus longitudinalis carries stimulating impulses, and the right fasciculus inhibitory impulses.

A labyrinthine impulse entering, for instance, the right vestibular nuclei has to be distributed in these nuclei in such a way (see diagram) that the cells sending fibers in the left posterior longitudinal bundle (L-cells) carry stimulating impulses, and that the cells sending impulses into the right fasciculus (R-cells) carry inhibitory impulses toward the midbrain. I mentioned before that this can be explained by some other experiments on reflex inhibition. One has to assume that in this case the main part of labyrinthine impulses reach the L-cells and the left fasciculus longitudinalis posterior. A small part of the stimuli that reach the L-cells are sent by collaterals of these cells to the R-cells, and in consequence there is a minimal excitation of these cells and their fibers. The cells of the corresponding ocular muscle nuclei (center of the right external rectus and left internal rectus) cannot be reached by this impulse, but the impulse leaves a refractory period on the way where it has traveled, and as a consequence, the impulses which normally maintain the tonicity of these muscles are lowered and the muscles are inhibited.

The analysis of the reciprocal inhibition of antagonists in the innervation of the slow component also shows a way for an understanding of the fast component of the nystagmus. Especially have otologists tried to solve the problem of rhythmic innervation found in nystagmus, by an attempt to localize a center of the fast component. But even if it were possible to show such a center, this would not solve the problem,

as this would not explain how such a center sends rhythmic impulses to the periphery at certain intervals. In any case, such attempts to locate a center of the fast component show us which groups of cells and fibers are necessary and which are dispensable for the production by labyrinthine stimulation not only of a conjugate deviation of the eyes, but also of the rhythmic reaction called nystagmus. The studies of Högyes, Kubo, Bauer and Leidler, and Magnus and de Kleyn have shown that the forebrain and even the forebrain plus the optic thalamus are not necessary for the genesis of typically labyrinthine nystagmus. These experiments show that the assumption of a special center of the fast component in the forebrain (Rosenfeld and others) is wrong. This assumption was based merely on the observation that, in narcosis and coma, only the tonic component of nystagmus is produced, which is to be explained by an action of the narcosis on the vestibular nuclei themselves. One can also extirpate the whole cerebellum (Magnus and de Kleyn), and still nystagmus can be elicited; so that only the medulla oblongata, pons and perhaps a part of the midbrain are necessary for the production of both components of the nystagmus. Bauer and Leidler even showed that a large part of the midbrain, including the nuclei of the oculomotor nerve, might be destroyed without the disappearance of the fast component. Recently, de Kleyn and Schenk observed an anencephalic child in whom a vestibular nystagmus could be produced in both directions, and in whom the cerebral hemispheres, the cerebellum, the nuclei of the third and fourth nerves and the ocular muscles, with the exception of the external rectus, were absent.

Within the limited area of the central nervous system, just mentioned, reflex arcs that are outside the connection of the labyrinth and its nuclei with the ocular muscle nuclei can also be dispensed with. This has been shown for the trigeminus by Högyes and his school, by Kubo and by de Kleyn, and by the latter author also for the centripetal impulses from the ocular muscles, conducted by the proprioceptive nerves of these muscles. Even the paralysis of these nerves by an injection of procaine hydrochloride into the ocular muscles did not prevent a typical nystagmus after caloric stimulation of the labyrinth. These experiments show that the theory of an orbital origin of the fast component (Ewald, Bartels) and especially the theory of a production of the fast component by proprioceptive impulses from the ocular muscles (Bartels) can no longer be held. It might finally be mentioned that a transsection of the medulla oblongata on the caudal border of the vestibular nuclei does not prevent the production of the labyrinthine nystagmus. In other words, the nerve connections caudal from these nuclei are not necessary for the genesis of this phenomenon.

It has been shown that the part of the central nervous system necessary for the genesis of both components of the labyrinthine nystagmus is limited to the centripetal fibers from the labyrinth, the centrifugal fibers to the ocular muscles and the central nervous system between these two groups of fibers. In which part of this area does the rhythm have its origin? Some authors, for instance Maupetit, have believed the labyrinth itself to be the place of origin, but it has been shown that, even after degeneration of the fibers from the ganglion vestibulare, rhythmic ocular movements can be produced by impulses from the vestibular nuclei. If one destroys the left labyrinth and, after some weeks, the right labyrinth, a nystagmus is produced to the side of the first operation (Bechterew's compensatory nystagmus, which has its origin in the vestibular nuclei themselves, following the experiments of Démétriades and myself). There is here a nystagmus that appears even after destruction of both labyrinths, or after the severance of both eighth nerves. Furthermore, Sato and I cut the eighth nerve on both sides and punctured the vestibular nuclei on one side; the last operation produced a forced position of the head and also nystagmus. Similar results were obtained later by Groebbels by galvanic stimulation after bilateral extirpation of the labyrinth in pigeons. An observation of Leidler points in the same direction. Eighteen days after severance of the left eighth nerve in a rabbit, he injured the arcuate fibers from the vestibular nuclei of this side, and observed, some minutes before the death of the animal, nystagmoid movements of the eyes. All these experiences lead to the conclusion that the origin of the fast component must be sought in the central nervous system itself, and that the peripheral organ can play only a secondary rôle in the origin of this fast component.

Is it possible that the rhythm causing nystagmus has its origin in the ocular muscle nuclei themselves? I analyzed this question experimentally on the oculomotor nucleus. Suppose that the centers of the internal rectus inhibit each other by fibers that cross the midline. If, for instance, the left internal rectus is stimulated, this stimulation might be associated with the inhibition of the right oculomotor nucleus by such crossing fibers. If, then, the left oculomotor nucleus becomes tired, the inhibition on the right nucleus would decrease, and so a reversal of the reaction would follow. In such a case, one posterior longitudinal bundle would be sufficient to produce a labyrinthine nystagmus of both eyes. I produced an injury in the pons, at the level of the right sixth nucelus, destroying the vestibulomesencephalic tracts on this side; then I extirpated the ocular muscles on the left side, with the exception of the internal rectus. If the hypothesis mentioned were correct, a stimulation of the labyrinth should still be able to produce rhythmic contractions of the left internal rectus and, thus, nystagmus

of the left eye. But after such an operation, I was unable to produce a nystagmus on the left eye by stimulation of the labyrinth. Hence, this hypothesis is untenable.

Marburg, Bauer and Leidler and A. Spitzer discussed the possibility that the origin of the fast component is in the vestibular nuclei themselves. Bauer and Leidler conjectured a special center for the tonic, and another for the rhythmic movements of the eyes. But, if one makes a graphic record of the ocular movements during nystagmus, one finds a rhythmic contraction of the muscles that move the eyes in the direction of the fast component, as well as of the muscles that move the eyes in the direction of the slow component. In other words, the cells that innervate the slow movement also send out rhythmic impulses. Hence, it is not possible to make a distinction between a tonic and a rhythmic center in the vestibular nuclei. In any case, it is to the credit of Bauer and Leidler to have shown that impulses conducted in the posterior longitudinal bundle may innervate both components of the nystagmus, and that the impulses for the innervation of the fast component might use this bundle on the one side, and the impulses for the slow deviation, the bundle of the opposite side; recently, this has been pointed out in more detail by A. Spitzer.

Experiments of Lorente de Nó led to different results. He found that, even after a bilateral severance of the posterior longitudinal bundle, rotation of the animal was still able to produce a rhythmic contraction of the ocular muscles innervated by the third and fourth nerves. On the other hand, he found after injuries of the formatio reticularis a disappearance of the fast component of the nystagmus; consequently, he localized a center of the fast component in this region, thus corroborating the theories of Bárány. I confirmed the first part of the experiments; I have also observed rhythmic movements of the ocular muscles, supplied by the third and fourth nerve, produced by labyrinthine stimuli, even if the posterior longitudinal bundle was destroyed on both sides. The same has been shown by Blohmke for the ocular movements that can be produced by an electrical stimulation of the optic thalamus. The aforementioned experiment of Lorente de Nó leads one to the opinion that the posterior longitudinal bundle is not the only path of the labyrinthine impulses to the ocular muscle nuclei in the midbrain. It seems that a second pathway for such impulses exists, furnished by short tracts that are to be sought in the substantia reticularis. But these experiments are still not sufficient to prove that a special center of the fast component exists in this region. To analyze this question, I injured the rhombencephalon from the ventral side after trephining the clivus between the bullae osseae. By this operation, I was able to produce extensive injuries of the formatio reticularis without injuring the posterior longitudinal bundle, or the fibers from the vestibular nuclei in this bundle, which fibers are necessarily severed if one injures the medulla

oblongata, or the pons from the dorsal side. In these experiments, I observed horizontal and vertical nystagmus even after extensive bilateral injuries of the formatio reticularis, following stimulation of the labyrinth by rotation. The direction of the reaction was not always typical after this injury, which might be due to the effects of shock on the vestibular nuclei, or to injury to a part of the vestibulomesencephalic systems localized in the substantia reticularis. In any case, these experiments show that the cells or fibers of the formatio reticularis are not necessary to produce nystagmus by labyrinthine stimuli. The impulses conducted in the formatio reticularis might modify the form of the nystagmus and they might be sufficient to produce nystagmoid movements of the eyes after a destruction of the posterior longitudinal bundle, but the existence of this region seems unnecessary to produce both components of the nystagmus by labyrinthine stimuli.[5]

One might conclude from all these experiments that the origin of the rhythm observed in nystagmus is to be sought in the central part of the reflex arc, which connects the labyrinth, the vestibular nuclei and the ocular muscle nuclei. It has been shown that the ocular muscle nuclei themselves and the substantia reticularis are not necessary for the genesis of this rhythm, and so one might conclude that the vestibular nuclei themselves are the place where this rhythm originates. To understand this mechanism, one might recall the explanation given for the slow deviation of the nystagmus. The slow deviation of both eyes, for instance to the left side, was explained thus: The L-cells of the vestibular nuclei are stimulated and the R-cells are reached only by lowered impulses, so that the vestibulo-mesencephalic tracts starting from these cells and innervating the muscles that move the eye toward the right side are inhibited. If abnormally strong impulses or those of long duration reach the L-cells, these finally become fatigued, and they will send no impulses toward the R-cells or toward the ocular muscles. The muscles that move the eyes to the left side will receive no more impulses, and, at the same time, the inhibition of the antagonists will cease. The muscles that move the eyes to the left side will relax due to exhaustion of the L-cells, and reflex impulses or impulses from higher centers can now reach the R-cells without inhibition, with the result that there are fast movements of both eyes to the right during the short period of exhaustion of the L-cells. When the L-cells have recovered, they again

5. Lorente de Nó objects that in my experiment Ny5 the fibers of the substantia reticularis just below the posterior longitudinal bundle were not cut. Histologic examination in this case showed a large hemorrhage in the formatio reticularis reaching close to the posterior longitudinal bundle. The area between the hemorrhage and the bundle itself was not normal; it was permeated with edema and distinctly less stained than the normal tissue. So it seems probable that this zone also was no longer able to conduct the nerve impulses in a normal way.

send impulses to the left external rectus and the right internal rectus, at the same time inhibiting the antagonists, and the whole cycle starts again.

The importance of impulses from higher centers that reach the vestibular nuclei (especially cortical impulses) is shown by the fact that the voluntary movement of the eyes in the direction of the fast component of the nystagmus increases the nystagmus. Furthermore, after extirpation of the forebrain on one side, a nystagmus is more easily produced with the fast component to the side of the operation than with it in the opposite direction (Korányi and Loeb, Bauer and Leidler, Dusser de Barenne and de Kleyn). This influence of the cortex on the labyrinthine nystagmus is explained by the fact that the corticofugal fibers for horizontal movements of the eyes reach the vestibular nuceli before they are transmitted to the ocular muscle nuclei, as has been shown for the impulses from the frontal lobe (Spiegel and Teschler) and for the impulses from the occipital lobe (Spiegel).

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News and Notes

EDITED BY DR. JOHN HERBERT WAITE

GENERAL NEWS

Centennial, Perkins Institution for the Blind.—On November 9, the Perkins Institution for the Blind, at Watertown, Mass., celebrated the hundredth anniversary of its founding as the first institution in the United States for the education of the blind. During the life of the school, 2,920 pupils have been registered, and for the current year 275 are enrolled in all grades from kindergarten through high school. Instruction is provided in the ordinary school subjects, and in the manual arts, music, domestic science and athletics. The aim of the school has always been to surmount the dependency of the blind, and to make them self-supporting, capable members of society.

Some of the important contributions of this school have been kindergarten instruction for the blind, the origination of the first sight-saving class in the United States and methods for the education of the blind deaf-mute. For those doubly handicapped, the school is provided with a Phipps unit, an electrical device which utilizes bone conduction to amplify hearing. Of special interest to the pupils is their ample library and large historical museum. The school has also an endowed press, which publishes books in Braille, and furnishes many institutions with other printed matter.

Middlemore Prize, 1933.—The Middlemore Prize consists of a cheque for 50 pounds and an illuminated certificate, and was founded in 1880 by the late Richard Middlemore, F.R.C.S., of Birmingham, to be awarded for the best essay or work on any subject which the Council of the British Medical Association may from time to time select in any department of ophthalmic medicine or surgery. The Council of the British Medical Association is prepared to consider an award of the prize in the year 1933 to the author of the best essay on the following subject, "The Treatment of Glaucoma." Essays submitted in competition must reach the Medical Secretary, British Medical Association, B.M.A. House, Tavistock Square, London W.C.1, on or before Dec. 31, 1932. Each essay must be signed with a motto and accompanied by a sealed envelop marked on the outside with the motto and containing the name and address of the author. In the event of no essay being of sufficient merit, the prize will not be awarded in 1933.

"Indicia."—At the end of this year, or at the beginning of next year, a new edition of the directory called "Indicia" will appear. This book contains data on the following subjects: (1) the names and addresses of all the oculists in the world, (2) the world's ophthalmologic journals, (3) the world's ophthalmologic societies, (4) public hospitals more or less exclusively devoted to diseases of the eyes and the number of beds at their disposal, (5) institutions and schools for

the blind and (6) statistics on blindness. Any one who desires to make suggestions or corrections concerning these items is invited to address his communications to E. Marx, Secretary, International Ophthalmological Council, Oostzeedyk 316, Rotterdam, Holland.

von Graefe Prize.—For the best articles which appeared in the *Archives für Ophthalmologie* from 1926 to 1928, the von Graefe prize has been awarded to Prof. M. Baurmann, Göttingen, for his "Investigations on the Structure of the Vitreous," and to Dr. P. A. Jaensch of Breslau for his article, "Fat Degeneration of the Cornea."

Wills Hospital.—On Saturday, November 12, the Wills Hospital at Philadelphia will open its new building with appropriate ceremonies.

Knapp Fund.—To serve in the place of Dr. A. E. Bulson, deceased, Dr. Parker Heath of Detroit has been appointed treasurer pro tem. for the Knapp Fund.

PERSONAL

On Dec. 9, 1932, Prof. Maximilian Salzmann celebrates his seventieth anniversary. This is an occasion which brings to mind not only his many contributions to ophthalmology, but also his association with the many Americans who have studied ophthalmology in Vienna. Professor Salzmann was born on Dec. 9, 1862, in Vienna and graduated as a physician in 1887. He was assistant in the Fuchs Clinic from 1888 to 1893 and then privat-docent and assistant professor; in 1912 he took charge of the eye department in Graz University, succeeding Professor Dimmer. His most important articles have been on myopia, keratoconus, ophthalmoscopy, the angle of the anterior chamber and iridectomy from the outside. His greatest achievement, however, is his "Anatomie und Histologie des menschlichen Augapfels" (Vienna, Franz Deuticke, 1912). He edited the thirteenth, fourteenth and fifteenth editions of Fuchs' classic textbook, and in the last edition contributed some important drawings of the fundus, which he himself had made.

SOCIETY NEWS

Congress of the Italian Societies for Oto-Neuro-Ophthalmology and Radio-Neuro-Surgery.—These two societies held their third meeting on Oct. 11, 12 and 13, 1932, in the neurologic clinic of Bologna, under the presidency of Prof. Carlo Cenj. The two main topics were: "Retrobulbar Optic Neuritis of Nasal Origin," by di Marzio and Ferreri, and the "Present State of the Surgery of the Hypophysis," by C. Cavina.

Obituaries

ALBERT EUGENE BULSON, M.D.

1867–1932

After a long illness which had confined him to his room six weeks before his death, Dr. Bulson, one of the foremost ophthalmologists in the country, died at his home in Fort Wayne, Ind., on July 17, 1932. Born in Chicago in 1867, he was graduated from the Michigan State College in 1888 and the Rush Medical School in 1891. He was intern in the hospital of the University of Michigan, and after a short residence abroad, where he took postgraduate studies in diseases of the eye, ear, nose and throat, he settled in Fort Wayne and remained in that city until his death. He soon acquired a large practice in the specialties in which he was interested and took a prominent part in local, state and national medical societies.

Dr. Bulson was a man of extraordinary ability and energy and would have succeeded in almost any walk of life. A splendid speaker, he presented his papers with great clearness, was convincing in discussion and was an admirable presiding officer of the many organizations, both medical and social, which he served. He was a great practitioner; his skill and resourcefulness as a surgeon combined with his executive ability and his personal charm enabled him to conduct his large practice successfully.

Apart from his practice, his industry and capacity for affairs enabled him to carry on many other interests. First of these must be mentioned his editorship of the *Journal of the Indiana State Medical Association*. This position he held from the journal's first issue in 1908 until his death. In a letter to me written shortly before his death, Dr. Bulson said, "With the December issue I am claiming twenty-five years as editor of the *Journal of the Indiana State Medical Association,* and I am planning upon an anniversary number. I have confided my plans to a few of the old wheel-horses here in Indiana, and it brings a lump in my throat when I think of the confidence, loyalty and friendly attitude exhibited toward me by so many of the fine men in our state and to have them say or write to me that the journal will stand as a splendid monument to my genius and ability long after I am gone." They are right, these friends of his, the journal is a splendid monument to him. An editorial in it after his death said of him: "As an editor he combined in an unusual degree clarity and vigor of statement, fairness and understanding with remarkable industry and devotion to medical journalism. The journal was his hobby, if a man so versatile can be said to have a hobby. He was open and frank, at times almost to the point of bluntness. His earnest, direct habit of mind did not suggest the

characteristics of the medical politician. Thorough acquaintance with all interests of his beloved profession gave him a well-balanced understanding of the various interests of his work."

Second to the journal came his connection with the American Medical Association. In this organization he served as a member of the House of Delegates from 1916 through 1931 and was repeatedly member or chairman of important reference committees. In 1929, he was elected vice speaker of the House of Delegates and was reelected annually thereafter. In the Section on Ophthalmology he was secretary from 1903 to 1909, chairman during 1910 and 1911, and again secretary from 1918 to 1919.

The Section meant much to him, for apart from his papers and the part he took in its discussions, which were all able and proved him alive to the rapid strides of ophthalmology during the past thirty years, as secretary, he strengthened it greatly by increasing its membership and its programs in quality. The Presessional Volume was his idea, and he ably seconded me in the institution of the Knapp Fund, and as its treasurer added annually to the number of contributors and safeguarded its securities. It may safely be asserted that since the establishment of the Section in 1878, no one has had greater influence on its development than Dr. Bulson.

Dr. Bulson was professor of ophthalmology and otolaryngology at the Fort Wayne College of Medicine from 1894 to 1908. He was professor of ophthalmology at Indiana University School of Medicine, Indianapolis and Bloomington, since 1908, and had been head of the department at the university since 1928. For many years he served on the surgical staffs of St. Joseph's and the Methodist hospitals. He was collaborator in the "Encyclopedia of Ophthalmology" and, in addition, was author of many scientific articles dealing with diseases of the eye, ear, nose and throat.

He was a member of the American Ophthalmological Society, of the American Academy of Ophthalmology and Otology and held membership also in many local, social and business organizations. From 1921 to 1924, he represented the American Medical Association as a member of the American Board of Ophthalmic Examiners, and the secretary of the board says, "His assistance was very valuable, and his loyalty to the board and the efficiency of his work were very conspicuous." He received the certificate of the American Board for Ophthalmic Examinations in 1917, and the certificate of the American Board for Otolaryngologic Examinations in 1925.

Dr. Bulson was married in 1892 to Miss Eva Maude Jeudevine of Detroit, who died in 1919. In 1923, he was married to Miss Memory Edith Breeden, who survives. Also surviving are two children, Miss Geraldine Bulson and Dr. Eugene L. Bulson, both of Fort Wayne.

WILLIAM CAMPBELL POSEY, M.D.

CHARLES ABADIE, M.D.
1842–1932

Charles Abadie died on June 29, 1932, at the age of 90, having been born in 1842, at St. Gaudens, which is near Toulouse. He became intern of the hospitals of Paris in 1868, and was particularly interested in surgery. Then the discovery of the ophthalmoscope opened up a new field, which attracted Abadie among many others. He studied in Vienna and in Berlin, where he became an enthusiastic pupil of von Graefe. On returning to Paris, he acted as chief of clinic of de Wecker. After the War of 1870, he started a small clinic in the Rue de Seguier. As was customary in France in those days, these private clinics gave free treatment to the poor and instruction to young ophthalmologists. In 1876, the clinic was moved to larger quarters in the Boulevard St. Germain. After the opening of the ophthalmologic services by the Paris Faculty, the teaching in the private clinics was restricted, though a free dispensary, with some clinical instruction, continued.

At this time Abadie's textbook on "The Diseases of the Eye" appeared, but his great reputation rested more on his marvelous operative skill, and it must be remembered that in those days, before cocaine, operations were more difficult. He was always attracted by therapeutics, and his main aim was to find a way of curing his patients. He contributed a number of important articles on clinical subjects, therapeutic investigations, operative procedures, such as extraction of the lens dislocated into the vitreous, and iridocapsulectomy. He was the first to introduce into France the intravenous method of treatment by injections. He was an advocate of the surgical treatment of trachoma with brossage. He was always interested in relations of the sympathetic nervous system to exophthalmic goiter, and to ocular diseases, such as glaucoma, and certain diseases of the retina and optic nerve, and was among the first to contribute to the knowledge of pathology and surgery of the sympathetic nerve.

It was at congresses and meetings of the local societies that Abadie was at his best. With his lively gestures, his remarkable voice, his intensity of conviction, he made a striking appearance.

During the past twenty years he had given up all private consultations. His medical interests, however, continued; he visited his old

clinic and attended the meetings of the ophthalmologic societies. He lived a happy life in the precious intimacy of a small group of friends, some of whom were admirable artists, and recently outlined his philosophy of life in a book entitled "Pour vivre heureux."

From L. DUPUY-DUTEMPS
Annales d'oculistique, September, 1932.

Correspondence

BRONZE PLAQUES OF PROFESSOR FUCHS AVAILABLE

Oct. 13, 1932.

To the Editor.—I have in my office a bronze plaque on a black wood easel, representing a likeness of the late Prof. Ernst Fuchs; it was presented to me by Professor Fuchs and his son; I prize it highly, not only on account of its associations, but because of its artistic merits.

The plaque measures 3 by 4½ inches, and the black stand measures 4¼ by 7¾ inches. Many ophthalmologists have admired the plaque and envied me on account of its possession.

When in Vienna last summer, I mentioned this to the younger Fuchs (Dr. A. Fuchs) and asked whether it was not possible to obtain some of the plaques for distribution among my colleagues. He said that duplicates could be obtained and would cost about $2.00 each.

It has occurred to me that I shall be doing many ophthalmologists who remember the late Prof. Ernst Fuchs with affection and esteem a favor when I put them in the way of obtaining this bronze likeness.

I am willing to undertake the work of ordering the required number of bronze plaques on stands and of forwarding them to those who desire them, if they will send me their names with a request to this effect. The price of $2.00 will be increased, of course, by the expressage, broker's charges and federal customs charges; but, even with these additions, the cost should not be more than $5.00 or $6.00 each.

CHARLES H. MAY, M.D., 698 Madison Avenue, New York.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

CONTRIBUTION TO THE ANATOMY OF CONGENITAL ECTROPIUM UVEAE (FLOCCULI IRIDIS). A. FUCHS, Am. J. Ophth. **14:** 865, (Sept.) 1931.

The author gives the clinical aspects of ectropium uveae, and remarks the paucity of histologic studies. He reports two cases and compares the histologic observations with those in an albinotic eye. He concludes that ectropium uveae congenitum consists of an abundant growth of large pigment epithelial cells, which give rise to the formation of folds and figures of spiral form on account of their abundant growth, with a thinning of the epithelium near the zone of reflection, where the epithelium turns from the posterior surface of the iris to the free margin of the iris.

W. S. REESE.

ANATOMIC AND EMBRYOLOGIC STUDY OF THE LACRIMAL MUSCLE OF DUVERNEY-HORNER. R. GALLENGA, Rassegna ital. d'ottal. **1:** 5 (Jan.-Feb.) 1932.

This muscle was described in 1755 by Duverney as arising from the os planum and inserting on the internal canthal ligament. An American, Horner, in 1823, made more exact observations and suggested its possible function in lacrimal drainage. The author has studied its comparative anatomy and its development and anatomy in man, being especially interested in the question whether or not it originates as part of the orbicularis, as is believed by some anatomists.

No muscle which could be identified with the one in question could be found in the horse or rabbit, and its presence is considered by the author as peculiar to man. Eighteen human embryos of from 25 to 428 mm. were studied. In the smaller embryos a doubling of the mass forming the internal rectus is noted, the mesial part of which is destined to form the medial part of Tenon's capsule. In the 52 mm. stage a group of cells, also arising from the internal rectus, is seen, which, as shown by its development in later stages, must be considered the earliest form of the lacrimal muscle. It comes into relation with a group of cells arising from the lacrimal prominence. In the 60 mm. stage the relation with the internal rectus has been lost. Hence its origin is independent of the orbicularis and is probably from the internal rectus. The so-called anterior lacrimal muscle, which has been confused with that of Duverney-Horner, is entirely distinct from it, and is an ill defined part of the orbicularis.

Dissections were made of nine adult skulls after removing the roof of the orbit and in frozen sections of the whole skull. The muscle was found to pass between the posterior crest of the lacrimal bone and the

two canaliculi. Fibers also pass to the caruncle and to the orbicularis of both lids. The muscle is especially well developed around the lower canaliculus, chiefly along its lateral wall and not forming a circular sphincter, as has been described by others. It has no relation to the lacrimal sac. Its principal action would seem to be on the inferior canaliculus and on the caruncle. The article contains a bibliography and twenty-one illustrations.

S. R. GIFFORD.

Conjunctiva

PHLYCTENULAR KERATOCONJUNCTIVITIS IN CHILDREN. P. WORINGER, Paris méd. 2: 398 (Nov. 7) 1931.

Woringer asserts that phlyctenular keratoconjunctivitis is of great interest in pediatrics since it is recognized that it has a relationship to tuberculous infections and is often an indication of latent tuberculosis. This entity has long been considered as one of the essential characters of a scrofulous syndrome running parallel to cervical adenitis and chronic rhinitis. It is less frequently encountered in children's clinics than in the services of ophthalmologists. The author found that 85 per cent of the children with phlyctenular keratoconjunctivitis had a positive cutireaction, which usually indicates scrofula; in 15 per cent a relation to tuberculous infection was not demonstrated. In more than two thirds of the cases of keratoconjunctivitis with a recently positive cutireaction, roentgenography showed developing lesions at the hilus. In children with these lesions the mortality is not higher. Keratoconjunctivitis seems to have a favorable influence on the development of tuberculous infection. In old patients who had had a phlyctenular keratoconjunctival infection from two to six years previously, roentgenography demonstrated cicatrices and regions of calcification that are opaque to roentgen rays and denote a good recovery of the bacillary lesions.

EDITOR'S ABSTRACT. [J. A. M. A.]

Congenital Anomalies

COLOBOMA LENTIS WITH ABNORMAL CILIARY BODY. T. H. BUTLER, Brit. J. Ophth. 15: 648 (Nov.) 1931.

The anomaly was seen in the right eye of a woman 23 years of age. The iris was brown. The external conditions, iris reaction, pupil, tension and fundus were normal. The media were clear. Vision equaled 6/12.

Examination with + 20 behind the ophthalmoscope showed in the lower aspect of the vitreous chamber, and close behind the lens, a smooth gray circumscribed mass suggesting a sarcoma of the choroid. With the loupe a brown mass, sponge-like in texture, with no trace of irregularity or vascularization was seen. In its center, but apparently unconnected with it, was a yellowish area. The dilated pupil disclosed a small coloboma of the lens.

The biomicroscope showed that the mass had the texture and color of ordinary uveal tissue, and that there was no vascularization. It merged with the ciliary body without an abrupt edge and had no irregularity of surface that might be present in a new growth. The white

area proved to be a flocculent filamentous deposit on the back of the lens. The lens, except in the colobomatous area, was clear.

The conclusion was that the mass was due to abnormal development of the ciliary body, probably a fusion of several processes, and that there could be no question of a sarcomatous growth.

W. ZENTMAYER.

Experimental Pathology

PRODUCTION OF GENERALIZED SYPHILIS IN THE RABBIT FROM OCULAR LESIONS. A. BESSEMANS and J. VAN CANNEYT, Compt. rend. Soc. de biol. **110:** 984 (July 25) 1932.

The instillation of a virulent emulsion of treponemes in the normal culdesac gave regularly negative results. In twenty-seven rabbits in which syphilitic ocular lesions were produced metastatic manifestations developed in only four: (1) cachexia, with loss of hair in irregular plaques; (2) osteoperiostitis of the nasal bones, with lacrimation and a mucopurulent nasal discharge containing treponemes; (3) abortions, and (4) bilateral orchitis. In two of these, treponematous infection of the preauricular, retromaxillary and popliteal glands could be demonstrated. In one of the control animals used for testing the infectivity of the organisms, metastatic bilateral keratitis developed. In none of the animals with ocular syphilis could treponemes be recovered from the liver, spleen or brain.

J. E. LEBENSOHN.

General Diseases

ARTERIOSCLEROSIS, HYPERTENSION, NEPHRITIS. R. SALUS, Med. Klin. **27:** 1885 (Dec. 24) 1931.

The theories on the correlation between arteriosclerosis, hypertension and nephritis, according to Salus, have undergone considerable changes in recent years. He discusses particularly the significance of the changes in the vessels of the fundus oculi. He shows that the so-called retinitis albuminurica is a gradually developing nutritional and metabolic disturbance which first affects the stratum pigmenti and the outer layers of the retina and which is recognized by its sequelae, mainly by the reparatory inflammation and by the fatty degeneration. The disease of the layers originates in their nutritional basis; namely, in the vessels of the choroid, or in the posterior ciliary vessels, respectively. The author further states than in all patients with retinitis albuminurica there exists or has existed hypertension. He also asserts that the so-called retinitis albuminurica has no relation to a renal disorder. A connection exists only so far as the two disturbances often concur. They are coordinated diseases of different vascular provinces. If in the course of an apparently benign hypertension there develops retinitis, the primary disorder can no more be considered as benign than as if severe renal or cerebral disorders existed. The now existing hypertension is the malignant form. Thus, retinitis has also a prognostic significance. However, in predicting life expectancy it has to be considered whether vital organs such as kidney or brain are involved. The usually quoted two year limit applies of course only to cases with

simultaneously existing severe renal disease, and even for these not always. In toxic glomerular nephritis, pregnancy, scarlet fever and similar conditions the prognostic significance of retinitis is of course different. This form of retinitis is curable because the infection, which is the cause of the production of toxin, is curable, or the pregnancy terminates or can be interrupted. In regard to the terminology the author states that the usual designation of "retinitis albuminurica" or "nephritica" should be discontinued, but he admits that it is difficult to find a suitable term. He suggests the terms scarlet fever retinitis, pregnancy retinitis and retinitis in hypertension, the latter term indicating the presence of malignant hypertension, regardless of whether or not renal changes exist.

[J. A. M. A.]

General Pathology

MIGRATORY TUBERCLES: THE SPREAD OF TUBERCULOSIS OF THE EYE. A. VON SZILY, Klin. Monatsbl. f. Augenh. **87:** 13 (July) 1931.

Tuberculous disease of the eye is an endogenous metastasis, usually carried by the blood. The tuberculous foci in the eye may heal, and still become reinfected repeatedly later. Also, the hematogenous intra-ocular tuberculosis may spread per continuitatem. Small secondary foci have been found in the neighborhood of a solitary tubercle.

The description of the special form of spread of intra-ocular tuberculosis, called migratory tubercle by von Szily, is illustrated by more than forty pictures. His observations prompt the author to hold the opinion that cells, groups of cells or giant cells, harboring tubercle bacilli, are the probable cause of the spread of intra-ocular tuberculosis. Even the early stages of solitary tubercles could be well observed in von Szily's specimen.

K. L. STOLL.

Glaucoma

PRIMARY GLAUCOMA AND FRAGILITY OF THE RED CELLS. A. FERRARI, Arch. di ottal. **39:** 147 (April) 1932.

The author reviews the evidence in favor of vascular anomalies or disease as the cause of glaucoma, first demonstrated by Angelucci in 1881.

The questions of increased capillary permeability and changes in the sedimentation time of the red cells are discussed. The latter has been found normal in glaucoma by recent observers.

The author studied the resistance of red cells to hypotonic solutions in fifteen patients with simple glaucoma and in fifteen normal persons. No differences of importance were found.

S. R. GIFFORD.

ANTIGLAUCOMATOUS IRIDENCLEISIS. H. G. A. GJESSING, Norsk mag. f. lægevidensk. **92:** 813 (Aug.) 1931.

Holth's antiglaucomatous iridencleisis with meridional iridotomy is Gjessing's method of choice in chronic glaucoma. Of his 152 iriden-

cleises since 1911, 22 were performed with total or peripheral iridectomy, and 102 with meridional iridotomy. After-examinations made by him in 122 eyes from 6 to 159 months after surgical treatment, showed that the tension was normalized in 87.7 per cent, the vision unchanged or improved in 79.5 per cent, and the field of vision unchanged or improved in 83.2 per cent. Averaging these values gives good results in 83.5 per cent. Gjessing says that there seems to be little danger connected with iridencleisis, particularly with meridional iridotomy, even in advanced glaucoma, and neither advanced age nor marked limitation in the field of vision is a direct contraindication.

EDITOR'S ABSTRACT. [J. A. M. A.]

Instruments

A DEVICE FOR PREVENTING GLARE IN ELECTRIC OPHTHALMOSCOPES. N. B. HARMAN, Brit. J. Ophth. **16:** 225 (April) 1932.

The device for preventing glare in electric ophthalmoscopes consists of a small thin-walled tube mounted within the hole of the ophthalmoscope; the forward end of the tube is cut at an angle so that there projects from the hole of the mirror a crescentic ledge or shield. No originality is claimed by the author for this device. He states that an instrument so constructed was possessed by J. W. T. Thomas of Cardiff, the origin of which he did not know. [This device was on an electric ophthalmoscope marketed in the United States many years ago.]

W. ZENTMAYER.

SCHIÖTZ' X-TONOMETER WITH CONVEX PLUNGER. BRUNO FLEISCHER, Klin. Monatsbl. f. Augenh. **86:** 629 (May) 1931.

Measurements with Schiötz' tonometer vary according to the shape of the lower end of the plunger, which has been constructed by Schiötz flat, concave and convex for experimental purposes. He found that reliable and constant results can be obtained with the convex plunger at the high tensions which the concave plunger will not register. Heavier weights are not required, except an additional weight of 2 Gm. in extraordinary tensions up to 120 mm. This is due to the more accurate adaptation of the convex plunger to the eye. The average values are from 16 to 28 mm. of mercury and vary but slightly in measurements made with the concave and convex plungers. The instrument is especially useful in daily practice.

K. L. STOLL.

MODIFIED DE WECKER'S SCISSORS. B. TREUTLER, Klin. Monatsbl. f. Augenh. **86:** 830 (June) 1931.

Realizing the limitations of de Wecker's scissors, Treutler modified them in two respects: Both edges of the cutting blades were sharpened and their tips pointed, and at the front and back of the instrument finger rests were attached. The double edged cutting surface allows insertion through the cornea, facilitates dissection of the membranes and permits the splitting of them. The finger rests on both sides of the instrument

allow a regulation and increase of the spreading facilities, and a more ready stopping of the cutting motion, by pressure or release with the thumb and middle finger on the finger rests.

Secondary cataracts, membranes and thickened cords have been divided; incisions have been made into the iris, and triangular excisions of membranes have been done successfully by the author. Prolapse of the vitreous and infections are less apt to occur when using this instrument than with a corneal incision by means of a keratome. K. L. STOLL.

Lens

PARATHYROID CATARACT. M. E. MARCOVE, Am. J. Ophth. **14:** 887 (Sept.) 1931.

In a man, aged 41, exophthalmic goiter developed. An operation resulted in improvement for one year, following which symptoms returned. He was again operated on, and ten days later showed signs of parathyroid tetany. This was relieved temporarily by the administration of calcium. Fifteen months after the operation the patient complained of failing vision. The biomicroscope revealed fine vacuolar opacities under the anterior and posterior capsules of each lens, chiefly in the pupillary area. A 2 per cent solution of ethylmorphine hydrochloride was given. General treatment consisted of daily injections of 30 units of parathyroid extract-Collip and 300 grains (19.44 Gm.) of calcium lactate by mouth. The patient improved and the opacities of the lens remained almost stationary. W. S. REESE.

THE INTRACAPSULAR EXTRACTION OF CATARACT. R. C. J. MEYER, Brit. J. Ophth. **16:** 156 (March) 1932.

An analysis of sixty-seven cases is given and a plea made for the wide adoption of intracapsular extraction by the technic described.

The steps are: paresis of the orbicularis palpebrarum, a suture to lift up the lid during the operation and insure postoperative closure of the eyelids, a suture inserted below or in the tendon of the superior rectus, a retrobulbar injection of epinephrine, a conjunctival flap, a Graefe incision, including from three fifths to three fourths of 180 degrees, a peripheral iridectomy, conjunctival sutures, lens extraction, after the method of Elschnig, and toilet of the wound.

Five eyes were lost (7.5 per cent). These cannot be set down as a fault of the operation, but rather as a lack of skill and knowledge on the part of the surgeon. Four eyes were lost after postoperative vomiting with expulsive hemorrhage attributed to too large a retrobulbar injection. (The eyes lost were operations nos. 4, 29, 42, 46 and 47.) Of the remaining sixty-two cases, in 51 per cent cataracts were removed in the capsule, in 12 per cent they burst through the capsule at the moment of delivery, and in 30 per cent they burst through the capsule early and became ordinary extracapsular extractions.

In five cases there was prolapse of the iris; none was large. In four cases iridotomies had to be performed. In five cases vitreous was lost.

The advantages and disadvantages of the operation are set down. "If the analysis of these results should result in a wider adoption of this operation, it will have achieved a useful purpose."

W. ZENTMAYER.

Lids

XERODERMA PIGMENTOSUM. F. B. BLACKMAR, Am. J. Ophth. **14**: 884 (Sept.) 1931.

This fatal disease is described and the case of a girl, aged 6 years, reported. The parents and one older brother were in good health. Another brother at the age of 3 weeks scaled as though blistered after any exposure to sunlight, and freckles appeared on all exposed parts of the body. He died of pneumonia at the age of 16 months. The patient's paternal great-grandfather died of cancer of the eye. This child at the age of 6 months appeared badly sunburned on one cheek; large vesicles soon formed and spread over the face as the summer advanced. The hands, feet and neck gradually became involved. Examination revealed a large, red, ulcerated growth covering the right lower lid. The skin of the face was tight and glistening, and there were many scars on the hands, face and neck. Large freckle-like pigmented areas were scattered over the face. The skin of the abdomen and chest was normal.

W. S. REESE.

Methods of Examination

CHROMORETINOGRAPHY. J. L. PAVIA, Rev. sud-am. de méd. et de chir. **2**: 1169 (Dec.) 1931.

Pavia asserts that chromophotography is a valuable complement to retinography and has been awaited for a long time by all ophthalmologists who recognize the importance of graphic documents in teaching as well as in diagnosis and prognosis. Although the retina cannot be completely photographed, chromoretinography permits a differential diagnosis between lesions of the choroid and those of the retina; also certain physiologic changes may in this way be made clearer. The important points in the technic are as follows: 1. A continuous current with the greatest intensity possible for the resistance is used. 2. The orange yellow screen is placed in the slit of a Zeiss retinograph. 3. Under complete darkness, the color film is placed in the plate holder, which is then placed in the retinograph. 4. The fixator is placed in a position horizontal with the eye. 5. The obturator of the retinograph is placed at the letter B (the bulb being ready to photograph); the time of exposure may vary from three to six seconds according to the following rule: (*a*) three seconds for the intensely red fundi without pigment lesions and with little or no glittering reflections, (*b*) four seconds for fundi with white lesions, (*c*) five seconds for fundi with fine or hemorrhagic pigmentations and (*d*) six seconds for all fundi with numerous glittering reflections. 6. After each sitting the patient is allowed to rest about five minutes, with the eyes closed. 7. Before one takes the chromoretinographs, it is advisable to take at least two retinographs with ordinary film.

[J. A. M. A.]

Neurology

ACUTE OPTIC NEURITIS ASSOCIATED WITH MYELITIS. MILIAN, LHERMITTE, SCHAEFFER and HOROWITZ, Rev. neurol. **2**: 257 (Sept.) 1931.

Milian and his co-workers summarize their cases as follows: A man, aged 37, on presentation gave negative reactions to blood and spinal fluid tests and in the following days proved to have signs of paresis in the lower limbs and visual disturbances which appeared about the same time as the signs of paresis. Shortly after the onset, the patient presented a distinct spasmodic paraplegia with marked exaggeration of the reflexes and extension of the toes, accompanied by dystrophies in subjective and objective (tactile and deep) sensitivity ascending to the sixth and seventh thoracic nerves and sphincterial difficulties marked by impotence. The paraplegia was accompanied by an increase in the albumin content of the spinal fluid without appreciable hypertension. The visual difficulties consisted in a decrease in visual acuity with edematous papillitis accompanied by a central scotoma for colors. In spite of treatment, the paraplegia increased; the spastic manifestations and accentuation of the sensitivity were the two chief manifestations. Appearance of an ascending urinary infection was concomitant with the sphincterial dystrophies, complicated finally by visceral localizations, particularly pulmonary and renal, which led to death in from six to seven weeks after the onset. Anatomically, the essential, fundamental lesion was present in the spinal cord and consisted in areas of demyelinization accompanied by neuroglial reactions, and in the optic nerve there were degeneration and inflammation. The authors believe that the case represented an autonomic disease, probably due to a neurotropic virus, different from other diseases described in the past. This disease of the brain and spinal cord was elective for the spinal cord and optic nerves, differing from analogous syndromes such as may be produced by syphilis of the brain and spinal cord, multiple sclerosis, necrotic myelitis, epidemic encephalitis and all the types of pseudo-encephalitis. They do not agree with other workers that this disease is a syndrome. [J. A. M. A.]

Ocular Muscles

CONCERNING COAL MINER'S NYSTAGMUS. M. BARTELS, Arch. f. Ophth. **127**: 358, 1931.

This article is mainly a reply to Ohm's papers on the same subject. Bartel's present view concerning coal miner's nystagmus is as follows: It occurs if one lives in subdued light just like the nystagmus that animals get when kept in the dark. It disappears when men or animals return to life in daylight. Whether the determining factor is the light intensity or the impossibility of fixing the eyes on certain objects is not decided.

Coal miner's nystagmus can be influenced by labyrinthal stimuli, but also by fixation, convergence and the direction of gaze. The theory that coal miner's nystagmus is caused by the maintenance of upward rotation of both eyes should be given up. Miners do not keep their eyes more in the upward position than in any other position.

The action of the motor apparatus of the eyes can be understood only if a coordination center is assumed the actual position of which is not known. All that is known is that the manifold stimuli meet each other in the posterior longitudinal fasciculus (perhaps also in the substantia reticularis). The coordination center probably lies near the pontile center of gaze (around the sixth nucleus). It is not probable that this center lies, as Ohm suggested, in the vestibular nucleus.

P. C. KRONFELD.

Operations

IRIS ANESTHESIA BY RETROBULBAR INJECTION AND PARALYSIS OF THE ORBICULARIS OCULI BY SEVENTH NERVE BLOCK. L. B. SOMERVILLE-LARGE, Brit. J. Ophth. **16:** 166 (March) 1932.

Retrobulbar injections are indicated especially in cases in which iris manipulation is accompanied by considerable pain and in which general anesthesia is frequently employed. Pain at the time of the operation is removed and postanesthetic vomiting prevented.

A 2 cc. hypodermic syringe is used, with a 1¼ inch (30 mm.) needle. One cubic centimeter of 4 per cent procaine hydrochloride is used. In excision or evisceration, three injections each of 2 cc. of 4 per cent procaine hydrochloride are made.

Two complications have been observed to follow retrobulbar injections. This serious complication occurred four times in eighty-four cases in all when iridectomy was to be performed for an acute rise in intra-ocular tension. In one instance it resulted in the loss of the eye from the loss of vitreous. The second complication is paralysis of the inferior rectus. This occurred in about 30 per cent of cases.

For seventh nerve block a 2 cc. hypodermic syringe with a three-fourths inch (18 mm.) needle is used, and 2 cc. of 4 per cent procaine hydrochloride is injected immediately below the depression caused by the condyle as it moves forward onto its articular tubercle when the mouth is opened. The needle is introduced until it strikes bone, where 1.5 cc. is injected. The needle is then slid a little way over the zygoma, and the rest of the injection is given to complete the paralysis.

A complication arises, owing to the injection being given around the main trunk of the nerve; all muscles supplied by it are affected, and one-sided paralysis of the orbicularis oris is experienced, resulting in a temporary interference with speech.

W. ZENTMAYER.

Physiology

THE DIFFERENCE SENSITIVITY (SENSIBLE DISCRIMINATION) OF THE DARK ADAPTED PERIPHERY OF THE RETINA. S. W. KRAVKOV, Arch. f. Ophth. **127:** 86, 1931.

The author determined the difference sensitivity for monochromatic light at points 7, 11.5 and 26 degrees temporally or nasally to the fovea on four persons. The determinations were made after the subject stayed in the dark room for sixty minutes. The thresholds of difference were found to lie between 0.12 and 4.87 (much lower than the central thresh-

old, which is around 0.01). The threshold of difference decreases with increasing eccentricity of the retinal point tested. It also depends on the intensity of the stimulus. This apparent deviation from Rechner's law can easily be explained if the intrinsic light of the retina is added to the denominator of the threshold of difference. From determination of the actual threshold of difference, it is possible to calculate the intrinsic light of the retina.

The absolute sensitivity of the dark adapted eye to light has a definite maximum at the eccentricity of 11.5 degrees, which, perhaps, is the point of greatest concentration of rods per square unit of retina.

The difference sensitivity of the human eye also increases with progressing adaptation.

P. C. KRONFELD.

Refraction and Accommodation

DISAGREEMENT OF THE TWO EYES IN READING. G. OVIO, Rassegna ital. d'ottal. 1: 14 (Jan.-Feb.) 1932.

In reading a book or journal of two pages, it is either folded over so that only one page is visible or it is held open, with both pages visible. In the first case it is usually held so that the middle of each line is equidistant from both eyes. The ends of the lines, however, are not equidistant, the right end being nearer the right eye and vice versa. The author has calculated that for a reading distance of 30 cm. and a book 37 by 23 cm., the distance between the eyes and print at the ends of the line shows a difference of 3 cm. When the book is held open, it is usually placed so that the line between the pages would be equidistant from the two eyes if the head were straight. The head, however, is usually turned toward the page being read, so that the same relative conditions obtain as in the first case described, except that the difference in distance between the two eyes at the ends of the line is slightly less, about 1.6 cm. This means that in either case the nearer eye should accommodate somewhat more than the other: in the first case, 0.32 diopter and in the second, 0.14 diopter, according to the author's calculations. Since such unequal accommodation is impossible, one eye will be accommodated for the object, while the other will see diffusion circles. The size of these are also calculated by the author for the schematic eye, and are found to be large enough to reduce the vision of one eye considerably if it were working at the limit of visibility.

Ovio admits that his calculations are theoretical and based on exceptional conditions. The diffusion circles are not clearly seen on account of chromatic aberration, which lessens their disturbing effect. The lines used in his examples are not found in ordinary books, which, if large, are printed in two columns; if not so printed they are read by turning the face to equalize the distances. Furthermore, reading is not usually done at the limits of visibility, and hence the eye that is not exactly accommodated still receives a distinguishable image. Ovio concludes that under ordinary conditions the disagreement which his calculations show plays no practical rôle.

S. R. GIFFORD.

IMBERT'S CHROMOPTOMETRY AS A METHOD FOR THE DETERMINATION OF REFRACTION. E. HAAS, Arch. f. Ophth. **126:** 528, 1931.

The author measured the chromatic aberration on a number of eyes (nine with emmetropia, seven with myopia and four with presbyopia) by determining the refraction for objects seen through a red glass filter (permeability, 620 to 690 millimicrons) and through a blue filter (permeability, 400 to 500 millimicrons). The refraction was taken by retinoscopy and trial case test for distance, which was found to be very easy with the red light but very difficult with the blue light. More accurate were subjective tests with an optometer outside of the range of accommodation or determinations of the near point for the two extreme wavelengths. All these tests showed the chromatic aberration of the human eye to vary from 1 to 2.5 diopters and to be independent (in a small series) from the refractive state, the degree of accommodation and the age of the patient. Imbert found with the near point method chromatic aberration of 6 and 7 diopters, which has not been confirmed by any other author.

Imbert and Pech devised a method of taking refractions by determining the point that lies midway between the focal point for the red and that for the blue rays. The patient looks at a visual acuity chart one half of which he sees through a red and the other half through a blue glass. The instrument is called the "ericiscope." The lens which makes both halves of the chart equally distinct or indistinct is the correcting lens for the respective distance.

Haas compared the results of a trial case test with the results obtained with the ericiscope and usually found differences of less than 0.5 diopter. The latter method is, therefore, fairly accurate (from the physiologist's point of view).

P. C. KRONFELD.

DECREASE OF REFRACTION PRODUCED BY INJURY: REPORT OF CASES. HUBER, Klin. Monatsbl. f. Augenh. **87:** 255 (Aug.) 1931.

Traumatic myopia has been observed frequently, but hyperopia after contusion of the globe has apparently not been described before. Huber observed three cases, one of them in a schoolboy who, prior to an accident, had myopia of 2 diopters in the right eye and of 1.75 in the left. The right eye was struck by a horse-chestnut, thrown by a friend, which caused hemorrhages in the anterior chamber and in the vitreous. Vision was 1.5 without correction in the right eye after the blood had absorbed and also six months later; this amounts to a decrease of 2 diopters in the refraction, which had remained unchanged during one-half year. In another case with 2.75 diopters of myopia the traumatic hyperopia of 0.5 diopters remained unchanged for more than three years. The phenomenon may be produced by a tear of the muscle of accommodation and a reduction of its tonus.

K. L. STOLL.

Retina and Optic Nerve

LIPEMIA RETINALIS. S. H. MCKEE and I. M. RABINOWITCH, Canad. M. A. J. **25:** 530 (Nov.) 1931.

McKee and Rabinowitch report a case of lipemia retinalis—the forty-second on record, including Joslin's two new cases. The level of

blood fat at which the condition disappeared was below that previously recorded. Analyses of the blood fat and other data obtained daily and correlated with ophthalmoscopic examinations suggest that the condition is also influenced by factors other than the degree of lipemia. The condition that theoretically leads to lipemia, namely, a cachectic condition affecting all cellular functions, including permeability, is suggested as a contributing factor [J. A. M. A.]

HEMORRHAGIC RETINITIS IN VOMITING OF PREGNANCY. H. J. STANDER, Surg., Gynec. & Obst. **54:** 129 (Feb.) 1932.

Stander believes that hemorrhagic retinitis appearing during the course of vomiting of pregnancy is of grave prognostic significance and an indication for therapeutic abortion. Routine and repeated examination of the eyegrounds should be conducted on all patients suffering from severe vomiting of pregnancy. The character of the hemorrhagic retinitis seen in two cases of vomiting of pregnancy make it probable that the ocular lesion is caused by a change in the permeability of the capillary walls. Necrosis in the interior lobe of the hypophysis is sometimes seen in fatal cases of vomiting in pregnancy. [J. A. M. A.]

ELECTROLYSIS IN DETACHMENT OF THE RETINA. C. GARCIA and C. CESPEDES, Rev. cubana de oto-neuro-oftal. **1:** 131 (March-April) 1932.

Retinal detachment occurred in a woman of 26, the area of involvement being half the inferior segment of the fundus. The patient was operated on three weeks after appearance of the condition. From a loss of the upper half of the visual field there followed, in thirty-five days after operation, a restitution to normal limits without scotomas. Ophthalmoscopic examination revealed no cicatrices, necrosis, alteration of color or other indication of the former condition. Visual acuity was 20/20 — six months after operative intervention.

The technic of the operation is as follows: The negative pole of a small galvanic apparatus is attached to some indifferent part. Under cocaine-epinephrine anesthesia a small opening is made in the conjunctiva over the area of detachment. The sclera is thinned with the point of a cataract knife. Here a platinum hypodermic needle is introduced, passing obliquely through the coats until it lies parallel to the detached part and just above the choroid. The correct position is verified by undulatory movements produced by the needle as seen through the ophthalmoscope. The serum is withdrawn into a small syringe. The positive pole is attached to the needle in place of the syringe, and a current of 2 ma. (maximum, reached gradually) is applied for about five minutes while the needle is moved gently over all parts of the pocket. The shutting off of the current slowly completes the operation. Immediately thereafter the negative pole is applied to the eye, using from 2 to 5 ma. for from ten to twenty minutes, to raise the intra-ocular tension. The latter procedure is carried out daily for a week. A compression bandage is applied, and the patient is kept supine for eight or ten days. The opera-

tion is recommended because each step is carried out under direct vision with the aid of the ophthalmoscope; it is comparatively simple, and the reaction is minimal.

S. L. RHODE.

THE PATHOLOGY OF THE "COMMOTIO RETINAE." R. ROSCIN, Arch. f. Ophth. **127:** 401, 1931.

The retinal edema that follows blunt injuries has to be considered as the result of transudation from the paralyzed retinal vessels. The author has not seen any definite relation between subchoroidal hemorrhages and the retinal edema as stressed by Berlin. He also objects to Wagenmann's statement that the choroidal vessels furnish the fluid that enters the retina. His anatomic observations speak more in favor of the assumption that the edema fluid comes from the retinal vessels. The fundus picture of commotio retinae is, therefore, the result of some mechanical insult to the retinal tissue plus temporary paresis of the retinal vessels.

P. C. KRONFELD.

Trachoma

INTRADERMAL TRACHOMATOUS REACTION OF TRICOIRE, BASED ON 511 CASES. R. BELOT, Rev. internat. du trachome **8:** 225 (Oct.) 1931.

Trachomatous antigen is prepared by Tricoire by triturating material from trachomatous granulations in physiologic solution of sodium chloride, incubating the mixture for two weeks and adding a few drops of 1 per cent tincture of iodine to the supernatant fluid. Of this preparation, 0.25 cc. is injected intradermally. In a positive test, a red papule develops in forty-eight hours; in a negative test, absorption ensues without reaction.

The author found the procedure diagnostically unreliable. Of 400 cases clinically diagnosed as trachoma, only 59 per cent showed positive reactions, while positive reactions were elicited in 43 per cent of 111 cases not found to be trachoma. Perhaps modification of the technic may result in greater specificity.

JAMES E. LEBENSOHN.

TRACHOMA AND TRICHIASIS AMONG THE ANCIENT GREEKS. A. GABRIÉLIDÈS, Rev. internat. du trachome **9:** 93 (April) 1932.

The word trachoma is first encountered in the writings of Dioscorides. Galen taught that stiffness and wrinkling of the internal palpebral surface were characteristic of the disease. Hippocrates and Aristophanes compared the granular aspect of the lids to the surface of a cut fig. The ancients discussed extensively corneal ulceration, xerosis, symblepharon and tylosis, but the Arabs were the first to describe pannus. Copper in various forms was the most valued agent in trachoma therapy; granulations were expressed, and grattage performed with ground fig leaves, dried bone, pumice stone and curets. The deviating hairs in trichiasis were touched with an agglutinating material, such as mastic, asphalt, snail slime or the juice of various plants, and glued to the adjacent normal cilia. Epilation was performed by fingers or forceps; for after-treatment, the blood of frogs, bugs, bats and ticks or the bile of snakes and pigs was recommended. Sometimes the ciliary bulbs were

destroyed by a horizontal linear incision or by cauterization with red-hot iron. Paul d'Egine raised the lashes by fastening a fold of skin between two reeds, until necrosis and cicatrization followed. A similar procedure, involving sutures instead, is described in the works attributed to Hippocrates. The ancients finally evolved an operation, similar to the modern transplantation of the ciliary border, in which an intermarginal incision was made, a horizontal semilunar section of skin removed and the gap sutured.

JAMES E. LEBENSOHN.

SENSIBILITY OF CORNEA IN TRACHOMA. E. ZITTING, Finska läk.-sällsk. handl. **73:** 837 (Nov.) 1931.

Of the seventy-three eyes examined in cases with trachomatous pannus of from two weeks' to forty years' duration, the sensibility of the cornea was slightly decreased in eleven, moderately in thirty-five, greatly in twenty-two and extremely in three; two were normal or nearly so. Zitting concludes that trachomatous processes reduce the sensibility of the entire cornea, particularly in the field of the pannus formation. The closer the pannus, the greater its extent, and the older the trachoma, the more marked is the reduction. Disturbances in sensibility are demonstrable after healing of the trachoma. The cases are tabulated.

[J. A. M. A.]

Tumors

PLEXIFORM NEUROMA OF THE ORBIT. MARÍN-AMAT, Arch. d'opht. **48:** 509 (July) 1931.

The author points out that this condition is extremely rare, only about sixty cases having been reported up to the present time. His case agrees with the classic description of a congenital, painless, slowly growing tumor, having the feel of a knot of fine threads and benign in type. The mass was completely excised from the lid and orbit, and histologic study demonstrated that it arose from the nasolacrimal and frontal nerves. Its histologic study was made by Hortega. The growth belongs in the still little known group of aneurotic neuromas or Schwannomas.

S. B. MARLOW.

Vision

A NEW DEVICE FOR TRAINING AND TESTING BINOCULAR VISION. T. H. WHITTINGTON, Brit. J. Ophth. **16:** 105 (Feb.) 1932.

The principle of training binocular vision, and later fusion, by coordination of eye and hand is made use of in a drawing stereoscope. Wax tablets are employed. A style is used to draw with, over a piece of transparent celluloid. Beneath this is the picture on tissue paper, and when the tissue paper is pressed by the style against the wax, marks are visible. Thus innumerable drawings can be made on one tablet.

The method is not meant for cases in which there is a severe amblyopia in one eye, or for cases in which there is constant and marked squint.

W. ZENTMAYER.

Vitreous

BLINDNESS (VITREOUS HEMORRHAGE) AND INTRA-ORBITAL CAUTERY. C. HAMBURGER, Deutsche med. Wchnschr. **58:** 178 (Jan. 29) 1932.

The author reports the case of a 62 year old person who nine months previously had had a vitreous hemorrhage with blindness which did not respond to various kinds of treatment. Three months previously the other healthy eye had a similar hemorrhage, which obscured vision to a greater extent than in the first eye. Bier is the originator of the idea of using a cautery in the orbital cavity. After a third procedure with the cautery the patient was able to walk on the street alone and to read newspapers. Bier also mentions a 20 year old patient who had had a bleeding three months previously and whose visual acuity returned five days after the treatment. The technic of the method with a Paquelin cautery is given in detail. The author rationalizes the procedure on the basis of the poor drainage of the eyeball, and feels that the cures were not accidents because of the fact that eyes not so treated do not improve.

L. L. MAYER.

Sympathetic Ophthalmia

HEMOTHERAPY AND SEROTHERAPY IN SYMPATHETIC OPHTHALMIA. A. VAZQUEZ BARRIERE, Rev. cubana de oto-neuro-oftal. **1:** 29 (Jan.-Feb.) 1932.

After a discussion of the infectious and anaphylactic theories of the production of sympathetic ophthalmia, which he does not consider antagonistic, the author reports two cases in which there was a negative Bordet reaction. The reaction was positive in a patient cured of an eye wound of seven weeks' duration and negative in one of five months' duration. Wood's intradermic tests gave a positive result.

In these cases, the author employed with success autohemotherapy after enucleation. He details the basis of hemotherapy and serotherapy from the patient and from immunized persons and thinks it indicated in cases of sympathetic ophthalmia, with other therapeutic measures. In cases which resist this treatment, he used the blood or serum from patients cured of sympathetic ophthalmia.

C. E. FINLAY.

Therapeutics

THE TREATMENT OF LIMBAL TUMORS WITH RADIUM. T. H. BUTLER, Brit. J. Ophth. **16:** 152 (March) 1932.

Because of the doubt among ophthalmic surgeons regarding the effect of radium on tumors of the limbus, the author believes the following cases may be of interest:

CASE 1.—A sessile tumor, measuring about 5 mm. in circumference, was seen at the limbus, with a pedunculated portion equal in extent. The surface of the tumor was nodular, and the surrounding conjunctiva showed numerous enlarged vessels. The biomicroscope showed sprays of growth spreading into the superficial part of the clear cornea, in

places reaching as far as the level of the margin of the pupil. The histologic diagnosis was hemangioma. After two applications of radium the tumor disappeared.

CASE 2.—The growth in this patient, a girl aged 18, was diagnosed clinically as limbal sarcoma. An eye spatula 8 mm. square containing 3.5 mg. of radium element was applied in actual contact with the growth, unscreened, for forty-five minutes. This was repeated about three weeks later. Further applications at monthly intervals over a period of four months, for from twenty-five to fifteen minutes, were made. When the patient was seen six years later there was no trace of the growth, but there were a few enlarged blood vessels in the region of the original tumor.

CASE 3.—In the third case there was an area of pigmentation at the limbus with a widespread invasion of the conjunctiva and the peripheral parts of the cornea with dots and islets of pigment as seen with the biomicroscope. The diagnosis was a melanotic malignant growth, most probably an epithelioma. Treatment similar to that in the second case was given, with thirteen applications over a period of about six years. At the time of the last examination there was a small collection of pigment dots in the region of the old tumor and in the superficial parts of the cornea.

CASE 4.—The fourth case was one of melanotic carcinoma of the conjunctiva, near the limbus, in a woman, 23 years of age. The treatment was the same as in the previous cases. Three years later the biomicroscope showed no trace of pigmentation.

CASE 5.—The last case was one of hemangioma at the limbus. The growth was excised and treated with 10 mg. of radium, unscreened, for forty minutes. This was repeated at the end of five weeks. About fourteen months later, screened radium was applied; this was repeated about ten weeks later. As the patient did not return it is assumed that she was cured.

W. ZENTMAYER.

TREATMENT OF OCULAR LEPROSY WITH GOLD COMPOUNDS. W. H. HOFFMANN, Rev. cubana de oto-neuro-oftal. **1**: 17 (Jan.-Feb.) 1932.

After reference to employment of gold salts in tuberculosis and other infectious processes and to the progress made in the manufacture of organic gold salts, the author details his experience in cases of leprosy in which he has had extraordinary success, especially in connection with the ocular lesions.

C. E. FINLAY.

Society Transactions

EDITED BY DR. JOHN HERBERT WAITE

AMERICAN OPHTHALMOLOGICAL SOCIETY

EMORY HILL, M.D., *Secretary*

New London, Conn., June 27-29, 1932

EDWARD C. ELLETT, M.D., *President*

A LOCAL ANESTHETIC IN OPHTHALMOLOGY. DR. WILLIAM H. WILMER, and (by invitation) DR. RICHARD TOWNLEY PATON, Baltimore.

Pantocaine (p-*n*-butyl-amino-benzoate of di-methyl-amino-ethanol), a derivative of procaine hydrochloride, is freely soluble in water and chemically stable.

The advantages of the drug are: its quickness of action; the depth of penetration; the freedom from smarting and irritation; the patient's toleration of the drug; little tendency to drying of the cornea; no dilatation of the pupil; no increase in intra-ocular tension; acts well in 0.5 per cent solution; combines readily with epinephrine, and is less expensive than certain other local anesthetics.

The disadvantages are: its toxicity on human beings and individual idiosyncrasy, which has not yet been determined.

SOME ESSENTIALS AND SECURITIES WHICH STABILIZE OPERATIONS ON OCULAR MUSCLES. DR. P. CHALMERS JAMESON, Brooklyn.

This article appears in full in this issue of the ARCHIVES, p. 654.

CYCLODIALYSIS COMBINED WITH IRIDECTOMY IN GLAUCOMA SIMPLEX: A PRELIMINARY REPORT. DR. H. W. WOOTON, New York.

Cyclodialysis is performed first, with the object of freeing the root of the iris. An iridectomy is performed immediately following this operation. This procedure has the same purpose as the operation described by Dr. J. W. Jervey in 1927, namely, the freeing of the root of the iris which is blocking the filtration angle, and then making the drainage permanent by an iridectomy. The operation differs from that of Dr. Jervey in that the freeing of the iris root is obtained by cyclodialysis and the subsequent iridectomy is performed in the usual manner. The paper contains an analysis of several cases in which the patients were operated on and the results to the present time.

DISCUSSION

DR. JOHN N. WHEELER, New York: In two cases I recently performed an operation like that reported by Dr. Wooton. In both of these cases there had been a long history of glaucoma following the extraction of a cataract. The irides were entirely adherent to the corneas and the pupils were obliterated, but in each case there was a possibility of vision of some sort. In these cases I elevated a large conjunctival flap in the lower temporal quadrant, and exposed the sclera and the cornea. I then made a scleral incision about 12 mm. through the cornea, introduced a spatula at an angle, and separated the choroid and ciliary body from the iris and the cornea. Before elevating the flap I made an incision under cover of the flap with a keratome and performed an iridectomy. Both patients did well, and four weeks after operation the tension was still below normal in each eye.

I think that when one has a case of glaucoma in which there are excessive adhesions between the iris and the cornea, the operation described is a reasonable procedure.

DR. ARNOLD KNAPP, New York: It seems to me that the more deformity we produce, the more we invite adhesions. I think that Dr. Wooton's results would have been just as good if he had omitted the iridectomy.

DR. E. C. ELLETT, Memphis: Will you make it a little clearer as to whether you make two scleral incisions?

DR. H. W. WOOTON, New York: I make two scleral incisions. The first one is made for cyclodialysis; then, about a week later, another incision is made for the iridectomy. The second incision is not made underneath the flap. In regard to what Dr. Knapp has said concerning the iridectomy, the results were not satisfactory with cyclodialysis alone. The result was excellent for a couple of weeks; then, apparently, new adhesions formed and the tension increased. It is my recollection that in all of the cases in which cyclodialysis alone was performed the anterior chamber evacuated into the scleral wound made by the cyclodialysis, and I was surprised to find that it did not do so in four of the cases in which both procedures were used.

A REVIEW OF THE CASES OF THE PATIENTS WITH GLAUCOMA ADMITTED TO THE MASSACHUSETTS EYE AND EAR INFIRMARY OVER A PERIOD OF TWO YEARS. DR. MAUD CARVILL, Boston.

A study was made of 457 patients with glaucoma who entered the clinic between March 1, 1928, and March 1, 1930. One hundred and ninety-five cases were classified as secondary glaucoma and 262 as primary glaucoma. Four of the patients had congenital glaucoma and 10, juvenile glaucoma. Ninety-one patients were treated with miotics, and 171 were operated on. Two hundred and fifty-five operations were performed, 5 of which were the Lagrange operation; 76, Elliot's trephine; 4, Szymanski's trephine; 80, iridotasis; 31, Lagrange-tasis; 31, iridectomy, and 28, Reese's iridectomy.

DISCUSSION

DR. ALLEN GREENWOOD, Boston: I wish to call your attention to the fact that the Massachusetts Eye and Ear Infirmary was one of the

earlier institutions to segregate certain types of patients into groups, and to have these groups followed up by social service workers. During the course of years, the results of various procedures can be statistically brought before us for careful elucidation.

Dr. John Green, St. Louis: The question of the early recognition of glaucoma is exceedingly important. We should strive to convert the attitude of the general practitioner from that of waiting to that of anticipation. When we encounter a patient with a family history of glaucoma, we should frequently apply tonometry and watch the patient for a possible increase in tension.

Dr. William H. Wilder, Chicago: The thing that impressed me was the fact that the proportion of so-called secondary glaucoma is so high, nearly one-half, or at least 40 per cent. The important procedure in determining whether a patient has any evidence of the secondary type of glaucoma is a careful study with the corneal microscope.

Dr. W. H. Wilmer, Baltimore: I have found one type of operation that gives me better results than any other. I have never published it, although I have used it for several years. An ordinary 2 mm. trephine is used, and complete iridectomy is performed. If the result is not satisfactory, I do a second trephine; I take a little bit of the iris in front of the first opening and with a Lagrange sclerotome take out all the tissue between the two trephine openings.

Report of a Case of Evisceration Performed for Hemorrhagic Glaucoma with Subsequent Orbital Melanosarcoma, and Finally Metastasis Resulting in Death. Dr. Martin Cohen, New York.

This case is reported on account of the unusual clinical course. A man, aged 59, whose physical condition was normal, had had intermittent pains in the left eye for about two years, but was not, during this period, examined by an ophthalmologist until an attack of pain occurred of one week's standing, when he complained of sudden loss of vision. An intra-ocular tumor was excluded. The diagnosis of the condition noted was hemorrhagic glaucoma, for which an evisceration of the globe was performed. No postoperative complications occurred. Eighteen months later, the patient again complained of pain, and a bluish mass was observed over the remaining scleral stump. Part of the mass was removed for biopsy; the diagnosis was melanosarcoma. Exenteration of the orbit was then performed. The patient remained well for about seven months, when he complained of right abdominal pain. Palpation of this region revealed an enlarged liver. The diagnosis was then metastasis of the melanotic orbital growth to the liver. The patient's physical condition then gradually deteriorated until his death.

DISCUSSION

Dr. F. H. Verhoeff, Boston: One of the lessons to be drawn from this paper is that "hemorrhagic glaucoma" is not always hemorrhagic glaucoma. Another is that evisceration should never be performed in such cases.

I think that it is always well to get the eye for pathologic examination, not only for the benefit of ophthalmic science, but for the benefit

of the patient. Not infrequently we find sarcoma in eyes in which it is not suspected. In sarcoma or in hemorrhagic glaucoma there is only one operation, and that is enucleation. In fact, I believe that that applies to all blind eyes. I do not see any use in operating on blind eyes. I have had to treat the other eye for sympathetic ophthalmia too many times.

Dr. Allen Greenwood, Boston: In a case of this sort evisceration is a poor operation. Patients who undergo an operation for sarcoma of the choroid should be warned to tell their surgeon and family physician the nature of the disease for which the eye was removed. I do not believe that the average surgeon realizes the importance of metastasis from sarcoma of the choroid to the liver.

Dr. W. L. Benedict, Rochester, Minn.: I wish to mention another possibility that could not be avoided even by enucleation. Frequently small sarcomas become loosened from their moorings and get into the tissues of the orbit, and there they form small cysts that are not recognized even though the eye is enucleated. Furthermore, we know that metastatic areas in the liver, and I think in other parts of the body, will grow more rapidly than the original extension tumor left in the socket after removal of the eye. In case there is no extension through the sclera, evisceration should be sufficient. Small areas of pigmented tissue in the conjunctiva and about the limbus may take on melanotic characteristics at almost any time. I have known a pigmented tumor to occur in a socket seventeen years after enucleation of the eye for an intraocular pigmented tumor. I cannot believe that this was a recurrence of the tumor matter left in the orbital tissue; rather it would seem that the tumor was taking on the melanotic characteristics of the pigmented tissue left in the conjunctiva.

Pathologic Changes in the Orbit in Progressive Exophthalmos: With Special Reference to Alterations in the Extra-Ocular Muscles and the Optic Disks. Dr. Howard C. Naffziger, San Francisco (by invitation).

This article will be published in full in a later issue of the Archives.

Premonitory Edema of the Lid in the Typhoid Group. Dr. S. J. Beach, Portland, Me.

This report describes the occurrence of edema of the lid in typhoid and paratyphoid fever. In these cases edema was the earliest indication of the disease, and it disappeared before any characteristic enteric symptoms developed. One case in which there was a delayed Widal reaction would presumably not have been diagnosed except for the recognition of the significance of the swelling of the lid. Similar conditions that have been described as influenza and as trichinosis have more probably been typhoid fever. These cases confirm the tradition that edema of the lid occurs in typhoid fever, which should be added to the list of the not too rare conditions, like trichinosis and cases caused by the ingestion of rat poison (thallium), in which it is an important symptom.

DISCUSSION

Dr. E. E. Holt, Jr., Portland, Me.: I saw two such cases in young adults. The edema was of the noninflammatory type, was present in

both eyes and involved both lids. In the first instance the patient was ambulatory, and later typhoid fever developed.

DR. JONAS S. FRIEDENWALD, Baltimore: It might be interesting in this connection to call attention to a sign that has been described by Dr. Hamburg, an internist of Boston, and was noticed by Dr. Osler. It consists of edema of the conjunctiva and swelling of the caruncle, and especially the semilunar fold, and has been found to be a characteristic premonitory sign in measles.

DR. WALTER R. PARKER, Detroit: I should like to ask Dr. Beach whether the possibility of acute nephritis was ruled out in his case.

DR. S. J. BEACH, Portland, Me.: In answer to Dr. Parker, the urine was repeatedly examined carefully in these cases and was absolutely negative every time in both of them. Dr. Friedenwald brought out what seems to be a good point in this connection; namely, that edema of the lid may occur in more than one condition. Among other things, typhoid fever and trichinosis should be kept in mind.

LEPTOTRICHOSIS CONJUNCTIVAE (PARINAUD'S CONJUNCTIVITIS): ARTIFICIAL CULTIVATION OF THE LENTOTRICHES IN THREE OUT OF FOUR CASES. DR. F. H. VERHOEFF and (by invitation) DR. MERRILL J. KING, Boston.

This article will be published in full in a later issue of the ARCHIVES.

ENDARTERITIS OBLITERANS WITH GANGRENOUS DESTRUCTION OF BOTH EYES. DR. ADOLPH O. PFINGST, Louisville, Ky.

A review of the peripheric vascular diseases would indicate a marked similarity between the cases variously classified, especially between cases that have been recorded as essential endarteritis obliterans characterized by a cellular hyperplasia of the intima and those reported as thromboangiitis obliterans, in which an organized clot forms in the vessels following an inflammatory involvement of the tunica media and adventitia. The author briefly pointed out the clinical and histologic features of the diseases of the blood vessels described under various captions.

A case is reported of a girl of 9 years in whom both corneas became gangrenous and totally destroyed. The child died, soon after the loss of her eyes, of an intercurrent disease—meningitis of probable otitic origin. A complete autopsy revealed damaged blood vessels in practically every region and organ of the body. The pathologic changes consisted of a cellular hyperplasia of the intima of the small and medium-sized arteries, including those of the scleral and choroidal coats of both eyes. Evidence of infarcts of a kidney and the brain indicated the existence of lesions identical with those causing destruction of the eyes.

DISCUSSION

DR. FRANCIS H. ADLER, Philadelphia: This case brings to mind one I saw a number of years ago when I was resident in a hospital. The case occurred in a girl of 14 years with a previous history of scarlet fever in whom chronic nephrosis and hypertension developed; she died, with symptoms of marked purpura hemorrhagica. There were changes in the vessels similar to those shown here. At autopsy, the kidneys

of this child were found to be like those of an old man—white and contracted. I should like to ask whether studies were made of the platelets, blood pressure and renal function. It is possible this is the same type of case, chronic interstitial nephritis followed by purpura.

Dr. A. O. Pingst, Louisville, Ky.: I did not make a functional test of the kidney; the child was not in a condition to enable us to do that. Of course, the question of etiology is an important one. On seeing the case, the first impulse was to think of syphilis. But this child was examined in every way; spirochetes were searched for in every organ at autopsy, but were never found. The family history was good; the mother and father were both well.

Mooren's Ulcer. Dr. Arthur J. Bedell, Albany, N. Y.

The author presented a clinical and pathologic study of a recent case of Mooren's ulcer, with colored photographs and photomicrographs. A report on the condition of the patient was presented before this Society in 1921.

DISCUSSION

Dr. F. H. Verhoeff, Boston: Microscopic examination showed a marked tuberculous infiltration, which included the episcleral tissue up to the surface of the conjunctiva, where the ulcer was present. If it is ever possible to make a diagnosis of tuberculosis from microscopic findings, this is certainly a case of tuberculosis.

Dr. John Green, St. Louis: There seems to have been no success in the treatment of Mooren's ulcer by conjunctival flaps. The late Dr. Derby, in discussing a paper of mine on the "Use of Conjunctival Flaps," related two or three cases of Mooren's ulcer in which that treatment had been tried, without success. It seems to me, however, that the fact that at least one of the cases related by Dr. Bedell showed nature's attempt to alleviate suggests that we should not discard this possibility as a means of combating this type of ulcer.

Dystrophia Adiposa Corneae. Dr. E. V. L. Brown and (by invitation) Dr. Dewey Katz, Chicago.

This article will be published in full in a later issue of the Archives.

Additional Experiments Verifying the Presence of Spirochaeta Pallida in the Cornea in Experimental Interstitial Keratitis. Dr. C. A. Clapp, Baltimore.

The author called attention to the divergent views held by many investigators as to the presence in the cornea of Spirochaeta pallida in either clinical or experimental interstitial keratitis. He referred to his preliminary communication on the subject in 1928, when he showed that the lesion could be induced in rabbits at will by injecting an emulsion containing the spirochetes either subconjunctivally or into the anterior chamber, the resulting keratitis developing about six weeks after the inoculation. In this series of experiments he demonstrated to his own satisfaction the presence of the organism by staining with Levaditi's method and subsequent microscopic study. Some of his colleagues, however, expressed the belief that the bodies which resembled spiro-

chetes were artefacts. In order to clear any doubt on the subject, another group of rabbits was inoculated. Of these, some were killed when the keratitis became acute. One half of the cornea was fixed in formaldehyde and stained by the Warthin-Starry method, by which the organisms could be recognized. The other portion of the cornea was macerated in physiologic solution of sodium chloride and the fluid inoculated into a rabbit's testis. In due time a typical syphilitic orchitis developed, and the spirochetes were demonstrated both by the dark-field examination and by staining. Proof of the presence of the organisms in the affected cornea seems to be complete.

AN UNUSUAL CORNEAL LESION, PROBABLY CONGENITAL AND FAMILIAL: A SLIT-LAMP STUDY. DR. G. E. DE SCHWEINITZ and DR. ALFRED COWAN, Philadelphia.

This communication concerned unusual corneal lesions observed in three members of one family, two others being unaffected, and in one other patient in whom a familial relationship to this disease could not be established. Two members of the family, however, owing to absence, could not be examined.

In each case both corneas were affected, and the condition in each instance was practically exactly similar. The lesions were more or less evenly distributed over the whole area of each cornea, but somewhat more densely in the central portions. The narrow slit revealed that the lesions lay in two or three planes, which were close together either in or immediately beneath Bowman's membrane. By direct illumination, the lesions appeared to be well defined, gray, plaque-like spots; by retroillumination, they were seen to be optically clear areas resembling small rain drops on a window. The epithelium, the deeper layers of the cornea and the endothelium were uninvolved; they did not interfere with vision. No exactly similar cases were found in the literature.

DISCUSSION

DR. A. E. DAVIS, New York: I have three unpublished cases, all in the same family, which, judging from the description given, were exactly similar to the authors' cases. The mother is 70 years of age; the two daughters are in the thirties. The vision is perfect in each case in spite of the rain drop appearance in the cornea and the gray deposit seen by the slit-lamp.

DR. BEN WITT KEY, New York: In 1922, I reported a case of what I called congenital zonular keratitis, with exactly the same appearance as that which Dr. Cowan has described.

DR. ALFRED COWAN, Philadelphia: Dr. Key's case was not mentioned because we felt from the description that it differed quite a good deal from ours, and it also gave a history of trauma.

CIRCULATION OF THE AQUEOUS HUMOR: IMPORTANCE OF THE OPTIC NERVE. DR. CONRAD BERENS and (by invitation) DR. ADOLPH POSNER, New York.

A review of the literature indicates that the few experiments that have been made on living human eyes for the purpose of proving that the optic nerve is an outflow channel for the aqueous humor have resulted in negative findings.

Weed and Wegefarth's prussian blue precipitation method was employed in most of our experiments. Of the animals used, a rabbit, a dog and a guinea-pig, only the rabbit furnished evidence of drainage of the aqueous humor through the optic nerve and the posterior portion of the retina. Of the five human eyes used for the experiments, one was normal and four were pathologic. No prussian blue granules were found in the optic nerves of the pathologic eyes. In the normal eye, however, the granules were seen to be arranged around the central vessels for a distance of 1.5 mm. from the papilla twenty-four minutes after the injection. The experimental evidence indicates that the intra-ocular fluids gained access to the perivascular regions of the central vessels of the optic nerve in the eye of the rabbit and in one normal human eye, and that no stain was found around the central vessels in four pathologic human eyes.

DISCUSSION

DR. JOHN N. EVANS, Brooklyn: The demonstration of the perivascular space rests not on the anatomic side, but the physiologic side. The fact that a human eye has been studied, I think, is great encouragement to us, particularly as the eye was as nearly normal as we could reasonably expect.

DR. JONAS S. FRIEDENWALD, Baltimore: I presume these experiments were inaugurated to throw some light on the problem as to whether there is a flow of fluid from the interior of the eye out of the optic nerve. The method of Weed and Wegefarth is difficult to interpret in this regard, because a diffusible substance such as prussian blue, which was the substance used in this experiment, can travel from the region where it is injected to another region, where it is precipitated, either by transport with fluid or by diffusion. Roughly, from the information given, it would appear that the distance traveled was greater than could be expected from diffusion alone. I think that one would have to assume, if that appears to be the case, that the material that diffused into the retina was caught up in the normal tissue currents of the retina and transported by this current to the perivascular region.

EXPERIMENTAL CATARACT IN VITAMIN G DEFICIENCY. DR. C. S. O'BRIEN, Iowa City.

This article will be published in full in a later issue of the ARCHIVES.

SIGNIFICANCE OF SPECIFIC INFILTRATION AT THE SITE OF INJURY IN SYMPATHETIC OPHTHALMIA. DR. BERNARD SAMUELS, New York.

This article will be published in full in a later issue of the ARCHIVES.

ALLERGY AND IMMUNITY IN OCULAR TUBERCULOSIS. DR. JONAS S. FRIEDENWALD, Baltimore.

This article will be published in full in a later issue of the ARCHIVES.

THE CLASSIFICATION OF HETEROPHORIA AND HETEROTROPIA UNDER THE STANDARD SYSTEM OF NOMENCLATURE. DR. WALTER B. LANCASTER, Boston.

Every disease is conceived of as having a site in some organ or part of an organ; this is the anatomic or topographic part of the classifica-

tion. Every disease has some cause; this is the etiologic part of the classification. The system provides an adequate number of anatomic subdivisions and etiologic categories which are listed in the recently published limited edition of the nomenclature (obtainable from Dr. H. B. Logie, 2 East One Hundred and Third Street, New York).

What is the site of exophoria? Is it in some muscle, motor nerve or nerve center, sensory nerve, primary or higher center or in the eyeball or retina? It may be in any one of these. They can be grouped together as the neuromuscular mechanism for binocular vision. This covers all the related parts from the sensory impulse starting in the retina to the termination of the efferent impulse in the muscles. Subdivisions of the neuromuscular mechanism are: the mechanisms for conjugate movements right, left, up, down, and the mechanisms for disjunctive movements of convergence, divergence, sursum-and-deorsumvergence and cyclovergence. Further subdivisions include the individual external ocular muscles. Their motor nerves are numbered under cerebral nerves, but are available, of course, for ophthalmic use. The paper proceeds to show how the different types of heterophoria and heterotropia can be classified anatomically, and then takes up the etiologic categories.

DISCUSSION

DR. T. B. HOLLOWAY, Philadelphia: It is the desire of the Committee of the National Conference on the Nomenclature of Disease that this system of classification be tried out in institutions that are equipped to handle it.

DR. W. L. BENEDICT, Rochester, Minn.: For those who are interested in the classification of diseases, this one offers one of the best aids for keeping a record of the various items that must be considered together that has come to our hand. There are many systems of classification of diseases out of which this one has grown. We have been more or less familiar with some of these for the past few years, because we have been particularly interested in building up such a system of nomenclature.

THE SCOTOMETRY OF RETINAL EDEMA. DR. JOHN N. EVANS, Brooklyn.

The evidence on which this study is based is presented in the form of charts of the central field. The material is arranged in three main groups. The first is experimental evidence and shows that normal scotomas (blind spots and angioscotomas) vary in size and structure after the breath is held, on compression of the neck, and when the head is held lower than the trunk. In the second group are arranged the charts that show widening of the normal scotomas under physiologic conditions, such as the menstrual period and mild general fatigue, when low systolic blood pressure is a constant feature. In the third group are arranged the studies of pathologic material. It begins with those mild derangements which merge with the physiologic, but which, when exaggerated, become frankly pathologic. Certain theoretical features are discussed briefly, but the material is presented as simple evidence subject to a number of explanations. The practical usefulness of these studies is emphasized, particularly as they apparently supply clinical data on changes not observable with the ophthalmoscope until a much later stage of the process has been reached.

THE LIGHT-STREAKS ON THE RETINAL BLOOD VESSELS. DR. W. H. WILMER and (by invitation) DR. H. F. PIERCE and DR. J. S. FRIEDENWALD, Baltimore.

This article will be published in full in a later issue of the ARCHIVES.

RACEMOSE ANEURYSM OF THE RETINA. DR. ERNEST F. KRUG, New York.

This article will be published in full in a later issue of the ARCHIVES.

PIGMENTATION OF THE OPTIC NERVE. DR. ALGERNON B. REESE, New York.

This article will be published in full in a later issue of the ARCHIVES.

ASSOCIATION OF SCLEROSIS OF THE CEREBRAL BASAL VESSELS WITH OPTIC ATROPHY AND CUPPING: REPORT OF TEN CASES. DR. ARNOLD KNAPP, New York.

This article appears in full in this issue of the ARCHIVES, p. 637.

CENTRAL FIELD STUDIES IN INTRACRANIAL LESIONS. DR. C. W. RUTHERFORD, Iowa City.

The defects in the visual fields that occur in connection with intracranial lesions can be most surely detected in the central area in 80 per cent or more of cases. The tangent screen and small white test objects in graduated sizes constitute the essentials of a suitable apparatus for exploring the central field. While defects in the fields have little localizing value by themselves, they serve to disclose the approximate location at which pressure is most heavily applied to the visual pathways; the point and degree of pressure will be influenced according to the stage of development of the lesion and the rate and direction of its growth. The size of the blind spot may not correspond to the degree of papilledema or atrophy indicated by ophthalmoscopy. Fields may show no defects when other evidence is positive, and they may show defects without other positive evidence, but in the majority of cases the fields are of practical value. Tumors and tumor equivalents show comparable field defects. Roentgenograms are less valuable than ventriculograms, except in the region of the sella. Anteroposterior localization according to pupillary behavior is not dependable.

DISCUSSION

DR. WALTER R. PARKER, Detroit: In the interpretation of field changes in cases of tumor of the brain, they can, in general, be divided into three groups: (1) field changes incident to papilledema; (2) those incident to optic atrophy, and (3) those due to interference with the visual tracts. Enlargement of the blind spot in papilledema, if the macular region is not involved, will often be accompanied by normal fields. In papilledema associated with neuroretinitis and swelling of the disk, there will be an enlarged blind spot and marked diminution of the central vision. In the late changes in tumor of the brain there may be the changes incident to general optic atrophy. In the third

group, the field changes may be due to involvement of the visual pathways in the tumor mass, or to pressure on the visual pathways incident to the formation of the tumor.

Dr. T. B. Holloway, Philadelphia: I have never believed that the central portion of the field can be measured as accurately with small white test objects as with colored objects. The most efficient test objects are small red or small blue ones.

Dr. C. W. Rutherford, Iowa City: I much prefer to manipulate the amount of illumination rather than to use a color this week and try to duplicate that color precisely for use the next week, because when I get a new pad of paper I do not know whether it is comparable to what I had before. There are so many things to consider when it comes to using colors that I prefer to reduce the amount of illumination to a point where the small white test object can be used.

BRITISH MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

Centenary Meeting, London, July 21-30, 1932

John Parsons, F.R.S., *President, in the Chair*

Ocular Manifestations of Lesions of the Fifth Nerve. Mr. R. Foster Moore, London.

The gasserian ganglion is the trophic center for all the sensory branches of the trigeminal nerve, the most important somatic sensory nerve of the body. From each cell body in the ganglion a single fiber arises, which bifurcates, sending one branch centrally to the nucleus in the medulla and one to be distributed to the tissues. Any pathologic process in these cells may be referred to the corresponding point of its peripheral distribution. Thus, this ganglion may be involved by the spread of inflammation from disease of the middle ear, and it may be involved in a basic meningitis, in a tumor of the cerebellopontile angle or in inflammatory or neoplastic processes in any part of its peripheral course. The trigeminal nerve is also of great importance in the production of headaches. There is a free interconnection between the trigeminal nerve and the congeries of arcs of the whole central nervous system, so it is not surprising that reflex reaction should spread. Referred pain is believed to be an expression of irradiation in the nucleus of the nerve. There are two anatomic factors which facilitate the spread of the stimuli within the fifth nucleus, and from one nucleus to the other: 1. Individual fibers of the primary neuron, ascending and descending, give off collaterals at different levels, so constituting a bond of integration between different levels in the nucleus. 2. There is a free communication between the two trigeminal nuclei, so that a close intercommunicating link is provided which associates all the diverse tissues from which afferent impulses are directed to this nucleus.

The resistance to the spread of impulses may be greatly reduced by strychnine, so as to allow an afferent impulse almost a free run of the whole central nervous system.

Herpes Zoster Ophthalmicus.—Herpes cornea, with which are closely allied dendritic and stellate corneal ulcers, has little connection with herpes zoster ophthalmicus. There is a close relation between herpes zoster and varicella. Head and Campbell showed that the ganglion was in a condition of acute inflammation, with profuse hemorrhages into it and its capsule. Herpes zoster appears to be an acute specific disease, some product of which shows a selective activity for the ganglion cells. The first local manifestation of the disease is pain, of a burning or lancinating character, over the area which in three or four days will be occupied by vesicles. The cutaneous phenomena are: hyperalgesia with an increased temperature, erythema, vesiculation, rupture of the vesicles, cicatrization and anesthesia. The ophthalmic division of the fifth nerve gives off a branch to the meninges before it enters the superior orbital fissure, the involvement of which may cause intense headache and vomiting, thus simulating meningitis. The secretory fibers to the lacrimal gland come from the seventh nerve, and so the secretion of tears is not affected.

The most important complications of herpes ophthalmicus are those which involve the eye, and these are: corneal diseases, iridocyclitis, sometimes with secondary glaucoma, ocular palsies and optic atrophy. These intra-ocular complications seem to occur in about 60 per cent of cases, and they usually occur after the eruption has passed its acme.

Pathology.—The pathology of herpes zoster raises the question of the occurrence of antidromic impulses. In 1901, Professor Bayliss produced dilatation of the vessels of the hindlimb of the dog by stimulation of the dorsal roots of certain lumbar nerves, and he believed that the passage of the stimuli was by sensory components of the nerve, and was due to their capacity for antidromic conduction.

Mr. Foster Moore made observations on thirty-seven cases of cataract in an effort to discover how soon the sensitivity of the part of the cornea involved in the section is restored, the time of the observation varying between forty-eight hours and thirteen years after the operation. The restoration of sensation occurs from below upward, and it seems to vary a good deal in its progress. However, in some cases sensitiveness was impaired as long as four years after the operation. Anesthesia of the cornea alone will not produce ulceration.

The presenter concluded with a description of a special type of ulceration in which a neuropathic element probably exists. During the World War, cases were seen in which there was a peculiar milky white coagulated appearance of the conjunctiva as a result of mustard-gas poisoning. Now, many years after this exposure, a condition can still be seen which counterfeits closely the appearance that was produced by the gas at the time of the exposure. In some cases the cornea becomes ulcerated, and the first occurrence may even be ten or twelve years after exposure to the gas. Ulcers extend deeply into the interstitial tissue, separating its layers, destroying much tissue, sometimes causing hypopyon and showing but little tendency to heal. The clinical course suggests a neuropathic cause.

Book Reviews

Kurzes Handbuch der Ophthalmologie. By Prof. F. Schieck, Würzburg, and Prof. A. Brückner, Bâle. Volume 7. Price, 160 marks. Pp. 978, with 263 illustrations. Berlin: Julius Springer, 1932.

This volume of the Kurzes Handbuch treats of the eye in connection with general diseases, and discusses treatment and hygiene.

Certain chapters have been entrusted to medical authorities, and the subjects are presented according to the latest advances in medical science. These are "Diseases of Metabolism," by Lichtwitz, Berlin; "Skin Diseases," by Lutz, Bâle; "Exophthalmic Goiter," by Zondek, Berlin; "The Commonly Used Medicaments," by Frey, Göttingen, and "Chemotherapy," by Steidle, Würzburg. The general principles of immunity are described by Dold, Kiel, while Schieck treats of the special immunity conditions in the eye.

The other chapters comprise: "Diseases of the Heart, Vessels and Blood in Relation to the Eye," by Kummell, Hamburg; "Tuberculosis and Syphilis," by Igersheimer, Frankfurt; "Other Infectious Diseases," by Zade, Heidelberg; "Poisons," by Sattler, Königsberg, and "Tropical Eye Diseases," by Bakker, Hilversum. The subject of physical therapy is most thoroughly covered by Comberg, Berlin, and Lenz, Breslau, writes on hygiene and the blind.

The careful selection of collaborators which has characterized the other volumes is again noticeable, and the ophthalmologic reader has the advantage of the latest and most up-to-date medical opinion in these important subjects. A great deal of information has been brought together in a comparatively brief space, so that this volume is one of the most useful in the series. The illustrations, many in color, are excellent, and each chapter carries a short bibliography.

A. K.

Proceedings of All-India Ophthalmologic Society. Volume 2. Pp. 163. Madras, India: Huxley Press, 1931.

The All-India Ophthalmologic Society, if it be a truly representative body, draws its membership from among men who have access to the greatest storehouse of ophthalmic material in the world. The possibilities inherent in such a congress are tremendous, and its proceedings should rank with our most valuable periodicals. Bearing this in mind, it is difficult not to be disappointed in this volume, the report of the second annual meeting.

With the exception of the opening addresses and an excellent essay by Shroff on "The Development of Indian Ophthalmology," the contributions are entirely clinical. This fact does not make for a well rounded publication. The views expressed on cataract surgery are interesting and in some cases helpful, but the prototype of most of the papers could be heard at any meeting of the eye section of any state medical society in this country. The very titles have a familiar ring: "Lesions of the Eye Due to Syphilis," "Infantile Amaurosis," "Four Cases of Albinism" and the perennial "Modification of an Eye Instrument."

As facilities for research multiply, these proceedings will doubtless take on a more balanced character, but for the present they read like a series of case reports.

G. M. Bruce.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Prof. F. de Lapersonne, 217, Faubourg St. Honoré, Paris.
Secretary-General pro tem: Dr. A. Churchill, 66, Boulevard St. Michel, Paris.

International Ophthalmologic Congress

Secretary: Dr. Franciso Poyales, Olozaga 3, Madrid, Spain.
Place: Madrid, Spain. Time, April 16-22, 1933.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Sir J. Herbert Parsons, 54 Queen Anne St., Cavendish Square, London, W. I.

Ophthalmological Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgoam Road, Bombay 4.
Secretary: Dr. C. R. Athawale, Bhatwadi Girgoam, Bombay 4.
Place: A. M. C. Free Ophthalmic Hospital Bldg., Poi Bawadi Parel, Bombay 12.
Time: First Friday of every month.

Ophthalmological Society of the United Kingdom

President: Mr. A. H. H. Sinclair, 6 Charlotte Square, Edinburgh.
Secretary: Mr. Humphrey Neame, 56 Portland Place, London, W. I.

Oxford Ophthalmological Congress

Master: Dr. Cyril Walker, Bristol, England.
Secretary: Dr. C. G. Russ-Wood, 12 St. John's Hill, Shrewsbury, England.

Royal Society of Medicine, Section of Ophthalmology

President: Dr. E. W. Brewerton, 73 Harley St., W. 1, London.
Secretary: Dr. P. G. Doyne, 60 Queen Anne St., W. 1, London.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.

German Ophthalmological Society

Secretary: Prof. A. Wagenmann, Heidelberg.

NATIONAL

American Medical Association, Section on Ophthalmology

Chairman: Dr. Frederick H. Verhoeff, 82 Commonwealth Ave., Boston.
Secretary: Dr. Parker Heath, 1551 Woodward Ave., Detroit.
Place: Milwaukee. Time: June 12-16, 1933.

American Academy of Ophthalmology and Oto-Laryngology

President: Dr. S. Hanford McKee, 1528 Crescent St., Montreal, Canada.
President-Elect: Dr. B. R. Shurley, 62 W. Adams Ave., Detroit.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.

American Ophthalmological Society

President: Dr. Thomas B. Holloway, 1819 Chestnut St., Philadelphia.
Secretary-Treasurer: Dr. J. Milton Griscom, 2213 Walnut St., Philadelphia.
Place: Washington, D. C. Time: May 8-10, 1933.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

SECTIONAL

New England Ophthalmological Society

President: Dr. David W. Wells, Hotel Westminster, Boston.
Secretary-Treasurer: Dr. Theodore L. Terry, 243 Charles St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. Hans Barkan, 490 Post St., San Francisco.
Secretary-Treasurer: Dr. J. Frank Friesen, 1208 Roosevelt Bldg., Los Angeles.
Place: San Francisco. Time: 1933.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. John H. Harter, 1215 Fourth Ave., Seattle.
Secretary-Treasurer: Dr. Francis A. Brugman, 806 Cobb Bldg., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

Saginaw Valley Academy of Ophthalmology and Otolaryngology

President: Dr. R. B. Smith, Alma, Mich.
Secretary-Treasurer: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw, Mich., or Bay City, Mich. Time: First Friday of each month, except July and August.

Sioux Valley Eye and Ear Academy

President: Dr. John B. Gregg, 101 S. Main St., Sioux Falls, S. Dakota.
Secretary-Treasurer: Dr. F. H. Roost, 420 Trimble Bldg., Sioux City, Iowa.
Place: Sioux City, Iowa. Time: November, 1932.

Southern Medical Association, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Wiley R. Buffington, 211 Camp St., New Orleans.
Secretary: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Place: Birmingham, Ala. Time: November, 1932.

Southwestern Michigan Triological Society

President: Dr. W. E. McGarvey, 802 Jackson City Bank Bldg., Jackson.
Secretary: Dr. Don C. Lyons, 1405 Union and Peoples National Bank Bldg., Jackson.
Time: Third Thursday of alternate months.

STATE

Colorado Ophthalmological Society

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Ralph W. Danielson, 258 Metropolitan Bldg., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. M. H. Gill, 36 Pearl St., Hartford.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. Thomas H. Hall, Jr., 617 Mulberry St., Macon.
Secretary-Treasurer: Dr. J. A. Smith, 700 Spring St., Macon.

Indiana Academy of Ophthalmology and Oto-laryngology

President: Dr. J. R. Gillum, 221 S. Sixth St., Terre Haute.
Secretary: Dr. J. Kent Leasure, 23 E. Ohio St., Indianapolis.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY
President: Dr. W. W. Pearson, 410 Sixth Ave., Des Moines.
Secretary-Treasurer: Dr. W. F. Boiler, 105 E. Iowa Ave., Iowa City.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY
Chairman: Dr. Wilfred Haughey, 303 Post Bldg., Battle Creek.
Secretary: Dr. H. O. Westervelt, 239 Pipestone St., Benton Harbor.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY
President: Dr. Harold J. Rothschild, 239 Lowry Bldg., St. Paul.
Secretary-Treasurer: Dr. Walter E. Camp, Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY
President: Dr. L. H. Huber, Livingston.
Secretary: Dr. A. W. Morse, Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY
Chairman: Dr. Charles H. Schlichter, 556 N. Broad St., Elizabeth.
Secretary: Dr. B. E. Failing, 31 Lincoln Park, Newark.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION
Chairman: Dr. D. F. Gillette, 109 S. Warren St., Syracuse.
Secretary: Dr. Frank M. Sulzman, 1831 Fifth Ave., Troy.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY
President: Dr. Axel Oftedal, 55½ Broadway, Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 516 Fourth St., Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY
President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY
President: Dr. Herman A. Winkler, 224 Thayer St., Providence.
Secretary: Dr. N. A. Bolotow, 108 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY
President: Dr. W. B. McWhorter, 106 E. Earle St., Anderson.
Secretary-Treasurer: Dr. G. M. Truluck, Orangeburg.
Time: April and December.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY
President: Dr. W. D. Jones, 3116 Live Oak St., Dallas, Texas.
Secretary: Dr. A. F. Clark, 1034 Nix Professional Bldg., San Antonio.

UTAH OPHTHALMOLOGICAL SOCIETY
President: Dr. D. W. Henderson, 75 S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. T. F. Welch, 14 Exchange Pl., Salt Lake City.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY
President: Dr. Frank P. Swart, 142 W. York St., Norfolk.
Secretary-Treasurer: Dr. H. G. Preston, 307 Professional Bldg., Harrisonburg.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION
President: Dr. O. H. Bobbitt, Medical Arts Bldg., Charleston.
Secretary: Dr. Harry V. Thomas, 95 Fairmont Ave., Fairmont.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Elbert A. Curtis, 65 Central St., Newark.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

Academy of Medicine of Toronto, Section of Ophthalmology

Chairman: Dr. P. J. F. Houston, 34 Hurndale Ave., Toronto.
Secretary: Dr. Alexander E. MacDonald, 151 Bloor St., W., Toronto.
Time: First Monday of winter months.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. L. C. Rouglin, 127 Peachtree St., N. E., Atlanta, Ga.
Secretary: Dr. William O. Martin, Jr., Medical Arts Bldg., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St., N. E. Time: 8 p. m., last Thursday of each month.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Harry Friedenwald, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. William M. Rowland, 906 Cathedral St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. W. F. C. Steinbugler, 515 Ocean Ave., Brooklyn.
Secretary: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. H. D. Andrews, 33 Allen St., Buffalo.
Secretary-Treasurer: Dr. Thurber Le-Win, 112 Linwood Ave., Buffalo.

Chicago Ophthalmological Society

President: Dr. Michael Goldenburg, 104 S. Michigan Ave., Chicago.
Secretary: Dr. Richard C. Gamble, 30 N. Michigan Ave., Chicago.
Place: Medical and Dental Arts Club. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. M. W. Jacoby, 2323 Prospect Ave., Cleveland.
Secretary: Dr. H. C. Rosenberger, 1065 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. Roy B. Metz, Hanna Bldg., Cleveland.
Secretary: Dr. Paul G. Moore, Medical Arts Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. L. F. Appleman, 308 S. Sixteenth St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. John B. Alcorn, 167 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. Edward W. Harris, 681 E. Broad St., Columbus, Ohio.
Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. O. M. Marchman, 1717 Pacific Ave., Dallas, Texas.
Recording Secretary: Dr. W. Mood Knowles, 1717 Pacific Ave., Dallas, Texas.
Corresponding Secretary: Dr. J. M. Potts, 1717 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. Cecil C. Jones, 1121 Equitable Bldg., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month, September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Raymond S. Goux, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. R. H. Seeley, 9 Court St., Rutland, Vt.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. R. H. Needham, 1304 Medical Arts Bldg., Fort Worth, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1011 Medical Arts Bldg., Fort Worth.
Place: University Club. Time: 6:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. Carl F. Snapp, 26 Sheldon Ave., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Walter W. Oliver, 26 Sheldon Ave., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. L. W. Raney, 609 Fannin St., Houston, Texas.
Secretary: Dr. J. F. Gamble, 201 Main St., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

Indianapolis Ophthalmological and Oto-Laryngological Society

President: Dr. John W. Carmack, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Albert N. Lemoine, 906 Grand Ave. ,Kansas City, Mo.
Secretary: Dr. Harold B. Hedrick, 618 Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

President: Dr. Ferris L. Arnold, 923 Security Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Clyde E. Harner, 312 Security Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from September to June.

Los Angeles County Medical Society, Section on Ophthalmology and Oto-Laryngology

Acting President: Dr. D. E. Godwin, 910 Security Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. F. H. Brandt, 1052 W. Sixth St., Los Angeles.
Place: Elks Temple. Time: 6:30 p. m., fourth Monday of each month from October to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. Albert P. Tibbets, 1801 I St., Washington.
Secretary Dr. G. Victor Simpson, Rhode Island Ave., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Oto-Laryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month. Annual meeting, Jan. 10, 1933.

Milwaukee Oto-Ophthalmic Society

President: Dr. T. F. McCormick, 324 Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. O. P. Schoofs, 324 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., third Tuesday of each month.

Montreal Ophthalmological Society

President: Dr. J. P. E. Bousquet, 66 Sherbrooke St., West, Montreal, Canada.
Secretary: Dr. J. A. MacMillan, 1410 Stanley St., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Hilliard Wood, 700 Church St., Nashville, Tenn.
Secretary-Treasurer: Dr. H. C. Smith, Medical Arts Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. Charles A. Bahn, 150 Baronne St., New Orleans.
Secretary-Treasurer: Dr. M. F. Meyer, Canal Bank Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
Secretary: Dr. Algernon B. Reese, 73 E. Seventy-First St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. L. G. Howard, 532 First Ave., Council Bluffs, Iowa.
Secretary-Treasurer: Dr. W. A. Cassidy, 1620 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Pittsburgh Slit-Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. William R. Weisiger, Medical Arts Bldg., Richmond, Va.
Secretary: Dr. R. W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

Chairman: Dr. E. S. Amsler, 53 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. E. W. O'Brien, 5 N. Goodman St., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Julius H. Gross, Carleton Bldg., St. Louis.
Secretary: Dr. Carl T. Eber, 1006 Carleton Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. Charles J. Boehs, Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. E. D. Dumas, 425 Medical Arts Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Robert C. Martin, 384 Post St., San Francisco.
Secretary: Dr. George N. Hosford, 490 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Third Tuesday of every month except May, June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. J. L. Scales, Medical Arts Bldg., Shreveport, La.
Secretary-Treasurer: Dr. W. L. Atkins, 505 Medical Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 7:30 p. m., first Monday of each month from October to June.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. David Hartin, Old National Bank Bldg., Spokane, Wash.
Secretary: Dr. W. W. Henderson, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. W. G. Dickinson, 504 State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. Harold H. Joy, 504 State Tower Bldg., Syracuse, N. Y. N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.

Tulsa Academy of Ophthalmology and Otolaryngology

President: Dr. Roy Dunlap, 108 W. Sixth St., Tulsa, Okla.
Secretary-Treasurer: Dr. Marvin D. Henley, 108 W. Sixth St., Tulsa, Okla.
Place: Medical Arts Bldg. Time: Monthly.